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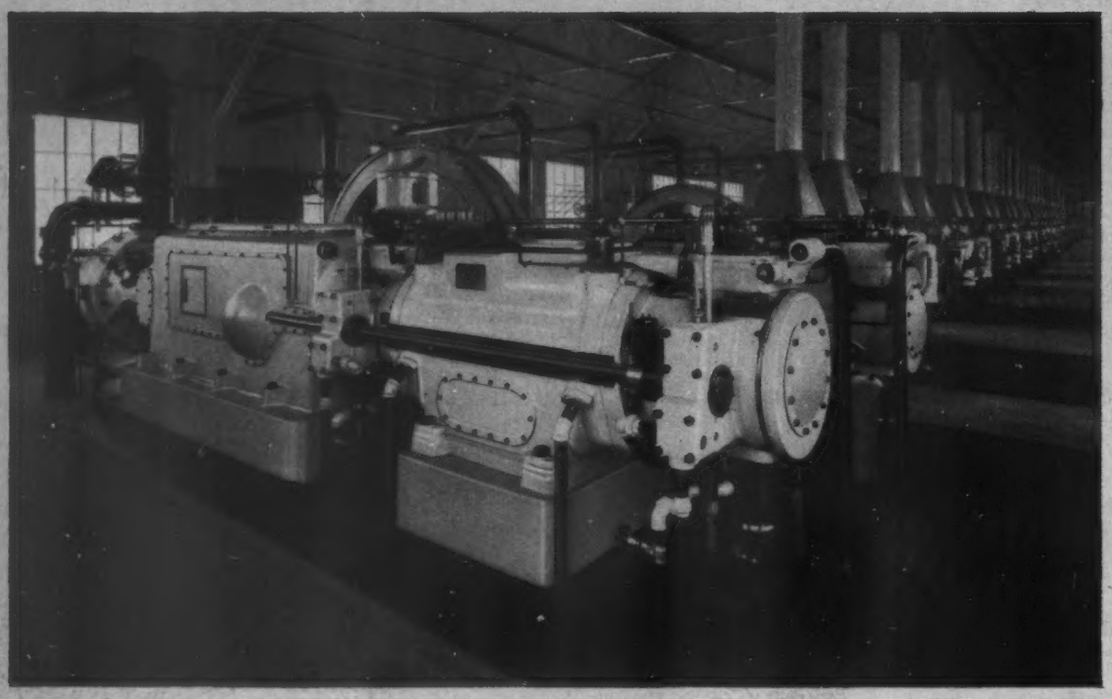

Photo shows one new Type-40 twin compressor unit in Sinclair Plant No. 17.

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REFINER
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VOLUME 10, No. 2 FEBRUARY, 1931

Progress in Distillation and Fractionation

By EARL PETTY
Refining Engineer, C. B. Roberts Engineering Company

FOR the past five years there have been very rapid strides in the art of distillation from a commercial development standpoint in all phases of fractionation and rectification on the entire range of petroleum products including natural gas.

Natural gas, refinery vapor products, both from recovery systems and from what is commonly called fixed gas from cracking and distilling operations, have received special attention. These problems are handled from a very basic and fundamental standpoint since the series of products or materials to be dealt with may be separated and resolved for the most part into pure compounds, the chemical and physical characteristics of which are rather definitely known.

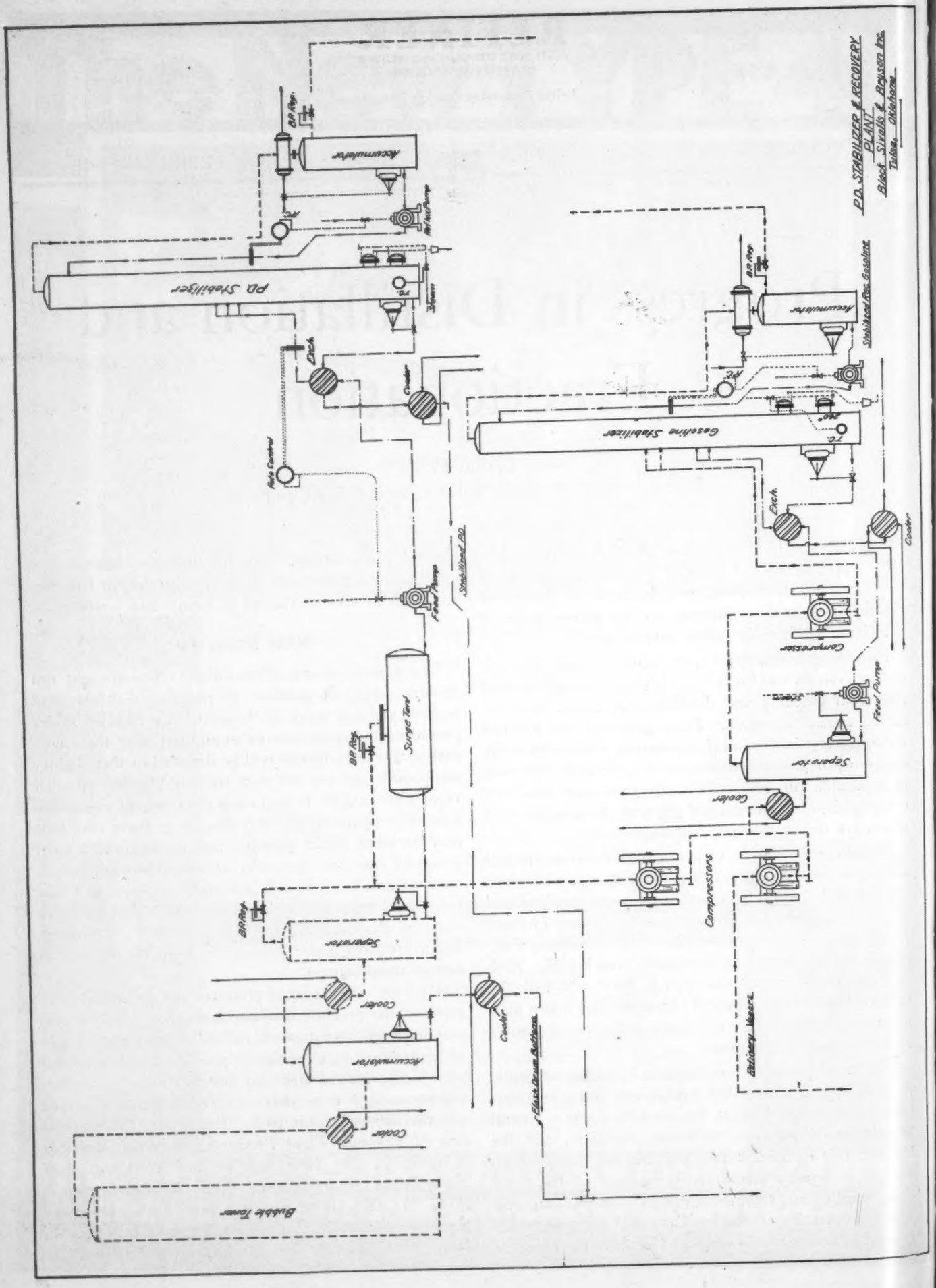
Meantime the subject of heat transfer through metals commonly used in heaters, heat exchangers, and coolers, has reached a very high degree of understanding and very reliable data have been compiled. (*See "Thermal Properties of Petroleum Products," Miscellaneous Publication of the Bureau of Standards, Number 97).* With the heat transfer problems well in hand and with the known chemical and physical characteristics it is a matter of calculation only, to design and forecast results from commercial operations.

The development of rectification by reflux of liquid through vapors to establish equilibrium and give a certain boiling range product, has brought about a general acceptance of pressure stabilizers, rectifiers, and the like. In this equipment the pressures are carried high enough to liquefy the larger percentage of the gases being handled and then enough heat is used to vaporize sufficient quantity of the liquid so that an appropriate amount of reflux can be employed in order to obtain the desired fractionation. This has brought about a new system and apparatus hook-up in refineries for handling materials heretofore classed as vapors and waste gases.

NEW SYSTEMS

The general system is as follows: The straight run gasoline, cracked gasoline or pressure distillate, and natural gasoline used for blending, are handled under pressures and temperatures so adjusted that these normal temperature liquids will be denuded of their lighter compounds and are left with an initial boiling point of from 150° to 200° F. or to suit the needs of the operators. The lighter products taken from these materials may be taken under pressure and divided into a light group of fractions, generally including propane, which is sometimes taken as a liquid under pressure and sold for special purposes, and lighter (which may be taken away as gas or fuel) and heavier range of products which are held under pressure to keep them liquid at normal temperatures.

After the original liquid products, i.e., the straight run gasoline, the pressure distillate and the rectified natural gasoline have been treated, redistilled, and made ready for motor fuel, then the lighter products which have also been highly fractionated and liquefied under their normal pressure at atmospheric temperature are reblended into the finished motor fuel. (*References, "Degasification of Pressure Plant Products," G. Reid,* REFINER & N. G. M., *July, 1930, page 97, and "Rectification of Natural Gas Hydrocarbons," I. N. Beall,* REFINER & N. G. M., *Dec., 1930, page 67, and "Stabilization and Recovery Plant," L. S. Gregory,* REFINER & N. G. M., *Nov., 1930, page 74, and "Degasification, Fractionation*


P.D. STABILIZER & RECOVERY PLANT
Black, Sivalls & Bryson Inc.
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P.D. Stabilizer
Gasoline Stabilizer
Accumulator
Surge Tank
Separator
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Cooler
Bubble Tower
Refinery Vapors
Stabilized Bot. Gasoline
Flash Down Bottoms

and Storage of Pressure Distillates," G. A. Burrell and R. P. Mase, REFINER & N. G. M., *Nov., 1929, page 77).*

Such operation reduces the common and conventional vapor recovery absorber system to a minimum and all of the intermediate treating, redistilling, and storage losses are largely reduced. By complete removal of the lighter materials a much larger percentage of the butane can be returned to the motor fuel blend and no difficulty in vapor lock be encountered and at the same time improve the quality and yield of gasoline. The removal of these light ends also reduces the volume of liquid to be treated, redistilled and stored by from 10 to 15 per cent. These lighter products usually require but very little, if any, treatment. The size of the vapor handling equipment is much reduced when designed for working under pressures at which the materials are liquefied.

Good fractionating equipment on primary distillation equipment handling crude oil has been universally adapted. Equipment capable of making fractions of very definite and close boiling ranges has been incorporated in all of the latest plants, not only with the idea of making the compounds for some commercial solvent or naphtha fractions, but also for making certain blends for improving the motor fuel value of the product. Stills and towers that are equipped and under control for such fractionation give no worry as to yields from the raw product being distilled, and often the finished product can be greatly improved, or the net return from these products be greatly increased, through sales for special uses.

Stabilization of straight run gasoline offers some wonderful possibilities to reduce losses, reduce the size and investment in vapor recovery equipment and improvement of the finished product and yield.

APPLICATION TO CRACKING

The application of fractionating equipment to cracking equipment is gradually coming into general practice. It has been found that even where end point fuel is not required, a p.d. which has been carefully rectified is not only easier to treat but is also of better motor fuel quality.

Another factor that is making fractionation equipment practical on cracking equipment is that the cycle of operation and the time stream of a plant has been increased to a point where the cost of the fractionation equipment is justified.

Heretofore, cracking equipment has been built of a very special and critical type of apparatus both as to pressures and temperatures. The time on stream was very short and the shut-down time represented a large percentage of the time available for operation. Thus for a certain monthly throughput, very large capacity units were necessary. In other words, if a production of 1000 barrels of pressure distillate per day were required and the unit only operated 85 per cent of the time, a unit of 1180 barrels per day would be required and the fractionating equipment would be enlarged by the same ratio and would lie idle the same per cent of time. This contributed to additional cost of the plant.

Present cracking stills with long time cycles of operation makes it practical to add the fractionating equipment. On account of treating problems it may still not be justified to make an end-point motor fuel but the improvement in color alone will simplify the treating operation and it has been found to have a great deal to do with the anti-knock value of the finished motor fuel.

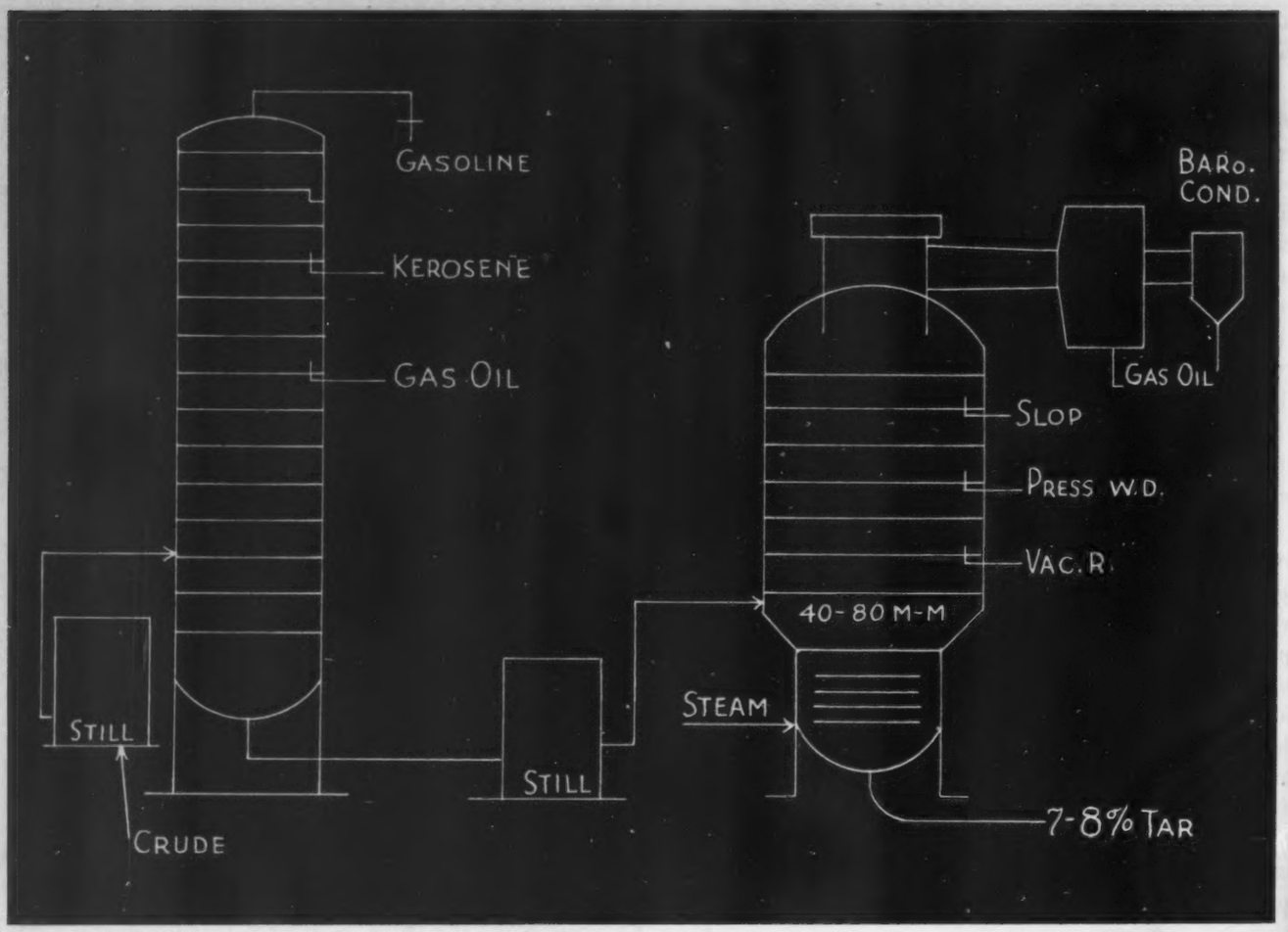
This fractionated pressure distillate may then be stripped of its low boiling fractions as mentioned above and the p.d. be treated and re-distilled in special frac-

EARL PETTY

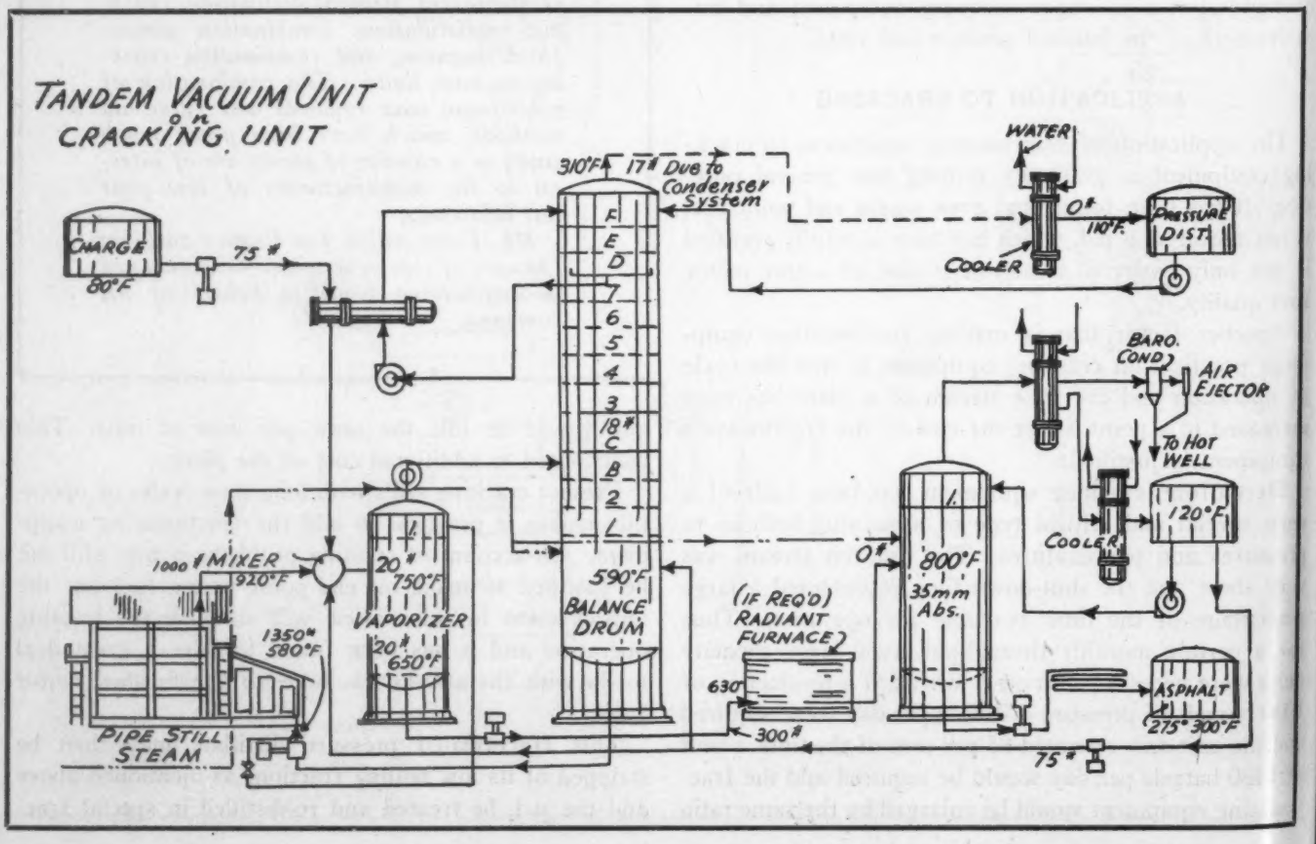
In regard to this article, Earl Petty, who is on the engineering staff of C. B. Roberts Engineering Company, states that these notes on distillation and fractionation are for general revision and for a more current picture of the trend of development, together with a review of units which have been placed in operation during the past year. This work is meant to supplement and further a similar discussion presented by the author in THE REFINER AND NATURAL GASOLINE MANUFACTURER, *"Handling Vacuum Distilled Wax Bearing Products," issue of June,* 1929, *page* 62.

Mr. Petty makes some interesting observations. He discusses the latest types of stabilizers, straight distillation, cracking, redistillation, combination atmospheric-vacuum, and combination cracking-vacuum units. The combination of centrifugal wax removal and filter aid methods, which have been given much study in a number of plants are of interest to the manufacturers of low pour test lubricants.

Mr. Petty sailed for France early in January of this year where he is engaged in engineering work in behalf of his company.



Conventional Topping-Vacuum Fractionating Column



tionating equipment for making the finished boiling range motor fuel.

This later mentioned operation brings in a special re-run or re-distillation unit which is being built in two types. The most conventional is the regular pipe still operating at atmospheric pressure. This gives much superior results than the old shell still re-run unit.

However a new type employs two separate flashing chambers, the first operating at atmospheric temperature and making the low boiling range fraction and the second operating under reduced pressure and making it possible to make the heavy fraction at a very low temperature. In this type of unit, either direct heating in the pipe still may be used or indirect heating using a carrier liquid through the pipe still and transferring the heat through heat exchangers at absolutely controlled ranges of temperature and rate of heating.

When a pressure distillate is handled in this manner a very superior product is obtained and on quantity production basis very economical operation is found.

This careful fractionation is carried on when producing kerosene, special domestic distillates, aeroplane Diesel fuel, etc.

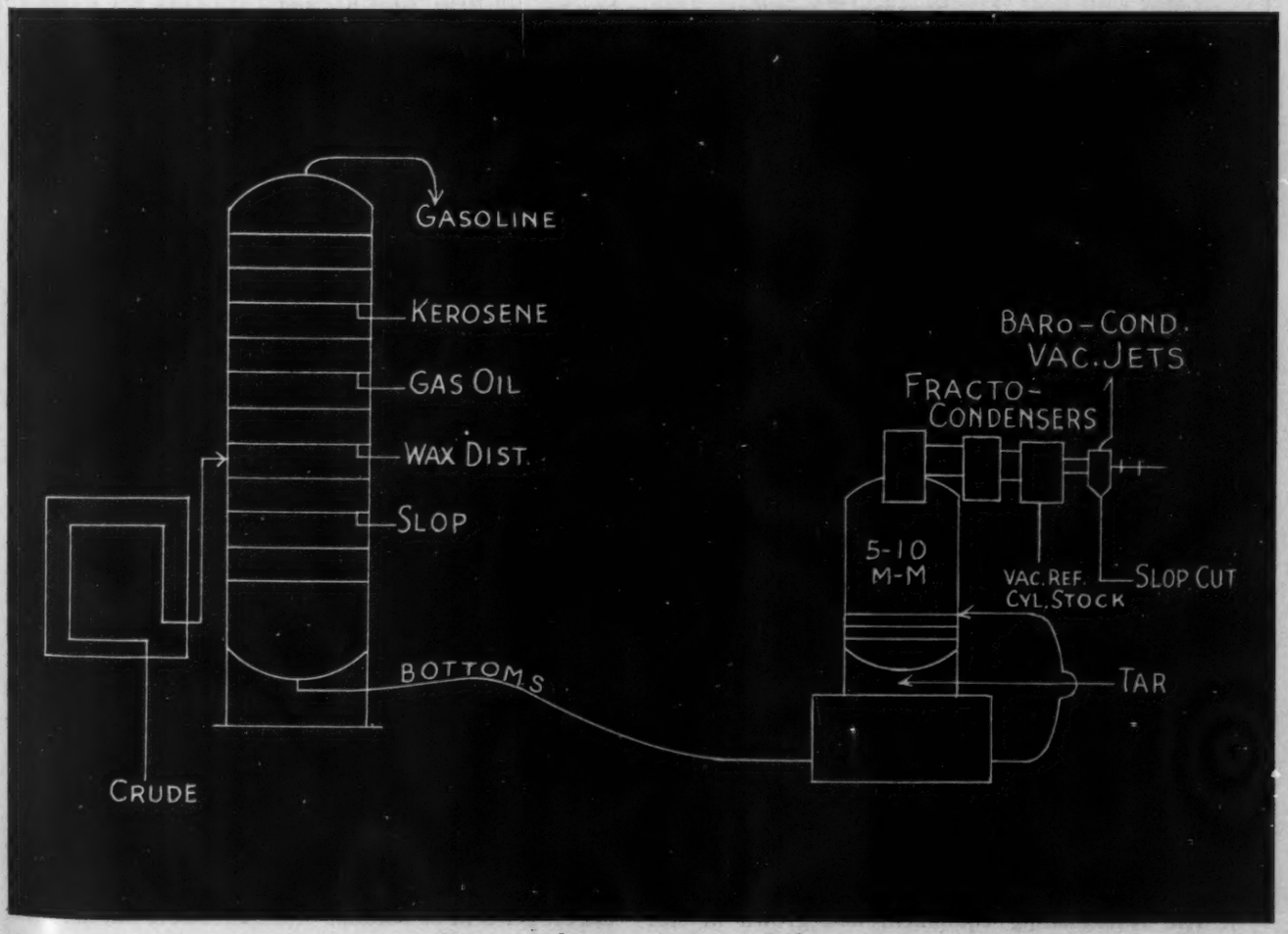
LUBE FRACTIONS

This brings the discussion to lubricating oil fractions and here a little review of the various methods and developments of the last year or so may be of interest. Commercial consideration of means of reducing temperatures by partial pressure effects, by using steam, lighter range boiling materials, has been reflected in various equipment during the last few years. By various combinations different plants have produced very similar results, each trying to obtain the maximum results in the most economical commercial type of apparatus.

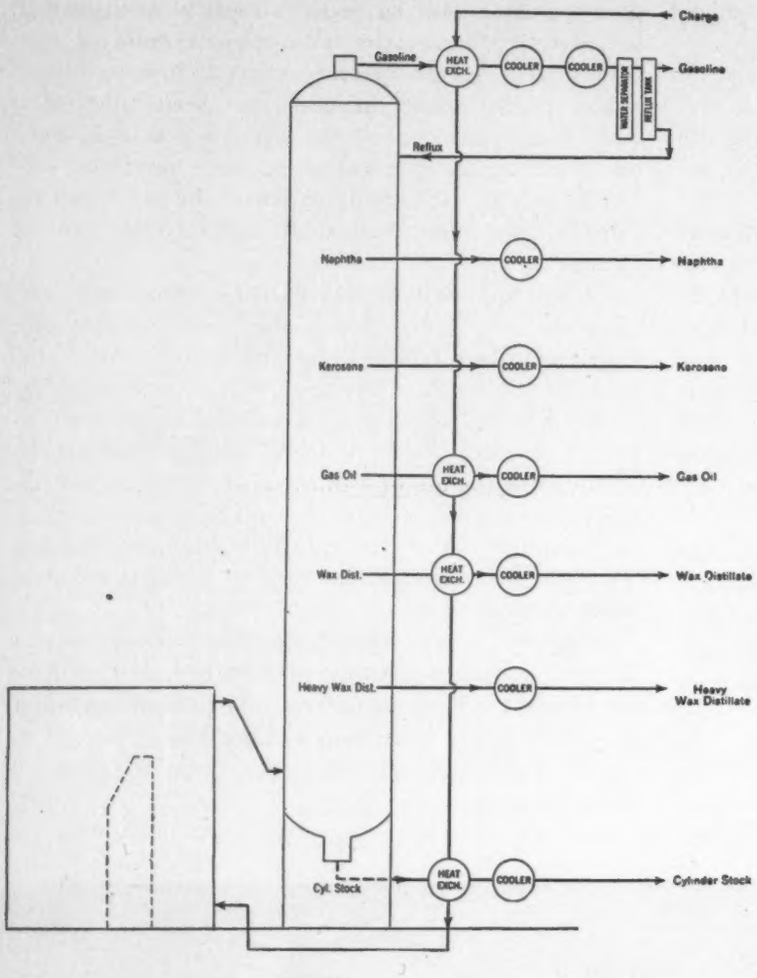
Enough information was at hand concerning fractionation that it was found that very valuable lube fractions of high boiling range and high viscosity could be made by flashing a mixture of long range of boiling compounds and thereby get a reduced temperature by partial pressure effects and still further improve this condition by the use of a third vapor, steam, so that the maximum amount of vaporization could be obtained at a temperature which would give the minimum cracking. Then by fractionation, the various products could be made simultaneously.

Such good results were attained by this method that at first it was considered the final method, as it involved the simplest type of apparatus and process operation. However, at the same time a European group of refinery technologists was utilizing vacuum processes for the same purpose.

American engineers began to experiment with re-



Vacuum System as per Schulz



duced pressures in combination with high fractionation equipment and single flashing of a long range boiling material,—viz, topped crude. (*Reference, "Application of Vacuum Distillation to the Production of Lubricating Oils," E. Petty,* REFINER & N. G. M., *Nov., 1929, page 90.)*

This latter system had certain inherent limitations as to final absolute pressures obtainable. However, with the use of steam and the partial pressure effect of the lighter materials very low effective pressures and temperatures were reached.

Later a final economic survey from practical operation and comparison of the various plants was compiled and the following details became prominent:

1. Operating pressures from 28 to 50 m/m hg. was the average vaporizer condition.

2. Tremendous amounts of steam was being consumed to produce this pressure as the vacuum equipment was operating under a pressure drop load due to the fractionating equipment involved for making gas oil, wax distillate, in some cases a slop wax, and an overhead vacuum steam refined stock distillate.

3. Additional steam was required for stripping and for partial pressure effect to prevent cracking and to lower the temperature.

4. The fractionating equipment had grown in size until it became very bulky.

5. The precision required for construction of this high-vacuum high fractionation equipment in such large sizes brings in a tremendous cost.

At the same time there was compiled information in connection with the various process requirements and problems brought about by the practice of high-vamuum high fractionating distillation for making lubricating oils.

As in the case with steam atmospheric fractionation, the wax distillate has been greatly improved and the dewaxing process on wax distillates greatly improved. Redistilling of wax distillate has been eliminated. Higher rates are obtained in pressing and lower cold tests results. Wax distillates for pressing are being prepared within certain definite boiling ranges and control is made by distillation tests for control of initial boiling points, per cent of fractions, and end point on gasoline. (*References on lube discussion, "Vacuum Units Lower Costs and Improved Products," by F. Reid,* REFINER & *N. G. M., Feb.,* 1930, *page* 94, *and "Schultz Process Applied to Hosston Crude,"* REFINER & *N.G.M., April,* 1930, *page* 81, *and "Nacogdoches Refinery Uses Combination Process," by N. F. Blaine, July,* 1930, *page* 73.)

A raw material from which stock can be made can be produced from black crudes and the cost of treating greatly reduced.

At first the dewaxing with the conventional centrifugal process offered considerable difficulty, especially when sub-zero could tests and cloud tests with high colors were attempted. A great deal of study has been given this problem in a number of plants and very satisfactory results are being obtained generally. At the same time much has been done with the idea of making a combination process using the centrifuge to "rough-out" the wax and follow with the "filter aid" system. This makes a "sandwich" idea, since the centrifuge has been found not to be fool proof and positive but is very fast and economical for removing the bulk of the wax. It is also a fact that the filter aid system has certain limitations when large quantities of wax are involved and a continuous process is required, but with a small quantity of wax and the requirement of a small amount of filter aid it is greatly simplified mechanically and has certain positive dewaxing and declouding ability that is very attractive.

CRACKING

In certain experiments in connection with cracking operations where it has been desired to make the very lowest per cent of bottoms of a flux nature but not make coke, a low pressure evaporator has been put in to

follow the primary cracking operation. In this system the residue from the primary cracking still-tower is taken through a secondary pipe still and further heat applied and then flashed into a vacuum chamber without any special heating equipment. The per cent bottoms obtained and the general characteristics of the overhead product have been surprising.

In other cases atmospheric—steam fractionating units have been followed with merely flashing into a vacuum chamber. This has given wonderful improvements but it is easily shown theoretically that further heat input is necessary to get optimum results.

Then in Europe refiners have stayed with the idea of continuous shell still operating where each still in the battery is operated under a certain temperature and pressure condition and using high fractionation only on the products where a fractionated product is required. Pipe stills have been built in combination with shell stills, using the shell still as an evaporator.

Meantime equipment manufacturers and refining engineers have not been content with calling any single installation perfect. In engineering practice there is always what is termed the "perfected" device, but never the "perfect." There is always the "last word" type of hook-up offered but there is always a new one being developed that is not quite ready for release. In practically every instance new equipment has justified its existence in comparison with the old or obsolete; but the demand has not grown as fast as the capacity of the installations of the new equipment; and it finally comes to a point where the new model runs fine but it was bought over-size and becomes a luxury. The time arrives then, where depreciation rate is small as compared to obsolesence rate.

Further, the refining industry has grown faster than has real sound, fundamental engineering and design and it arrived at a period where there was a very big industry discovered to be operating on "rule of thumb" methods. During the last 10 years extensive pressure has been put on scientific and fundamental commercial development and designing, and equipment engineers have been building these data into plants as fast as they were available.

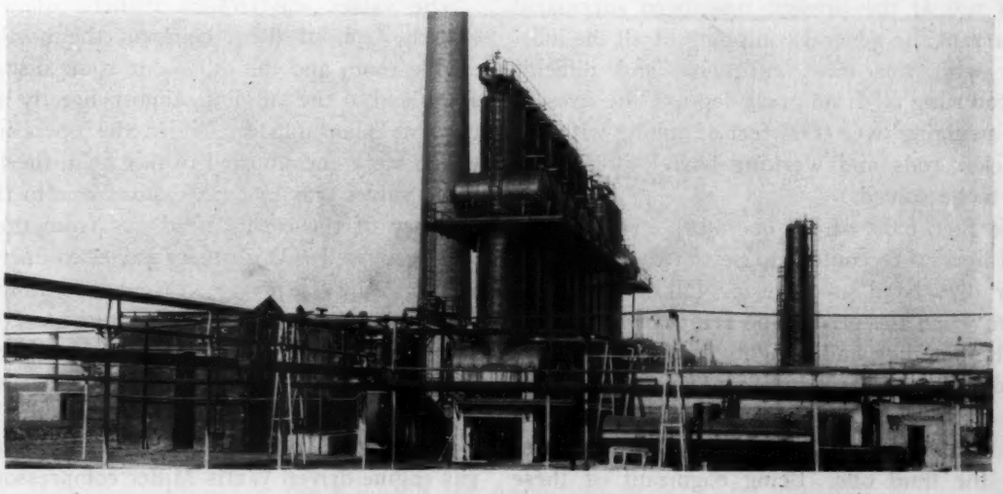
The result has been that a great improvement has been made and the industry is now on a fundamental and sound basis from the scientific standpoint, but of course, not yet perfect.

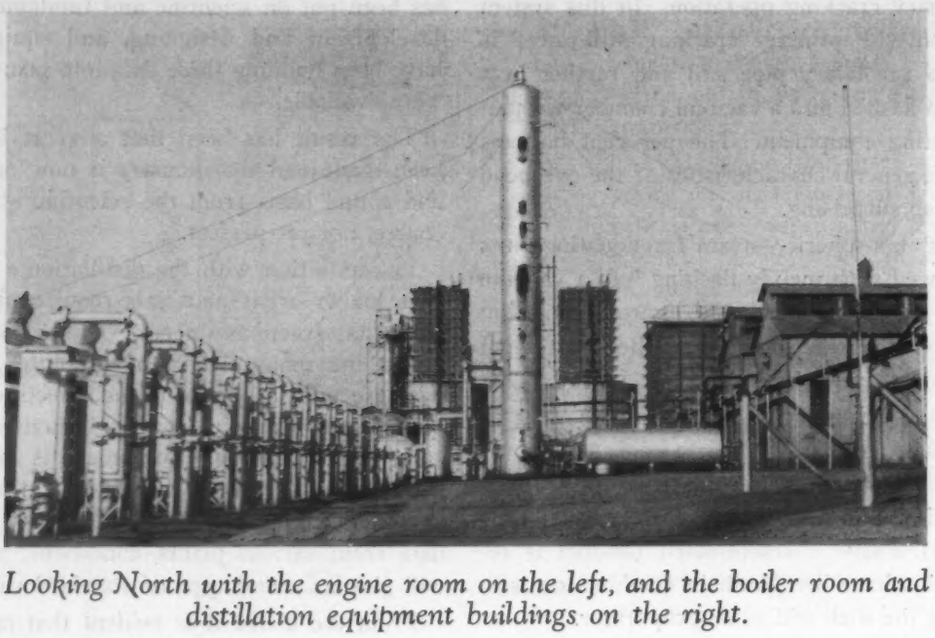
In connection with the distillation of lubricating oils it is known what materials require high fractionation and what fractions do not. The economic balance between the manipulation of absolute pressure, partial pressure effects by steam and effects of certain maximum temperatures as to yield, quality and overall results is also known. Equipment is in operation with absolute pressure from 40 to 80 m/m hg. to 10-15 m/m as practiced by the Schultz Process. This operation data from various plants, conditions, and requirements will give us a new type of standard vacuum unit.

From the above it is evident that our developments come along in quite definitely marked periods. Each period gives us equipment with certain definite classification marks. Each period may be divided into types as developed by certain "schools" or groups.

Thus we have the following period examples: Batch Stills, Shell and Cheese-box; continuous shell stills; continuous shell stills with developments in heat exchangers and fracto-condensers; shell stills with packed towers and simple fractionating columns; pipe stills, combinations with shell stills, re-circulating stills and multiple flash systems; pipe stills, single flash, steam-atmospheric; and pipe stills, combinations steam-atmospheric, high fractionation, with vacuum units operating under high fractionation.

Parallel with this development on crude oil distillation has been similar developments in handling the products of natural gas and light vapors, re-running problems, and the like. Hydrogenation is coming and while it is primarily a new process, yet it is adapting the same fractionating and re-run units of the other systems.





Looking North with the engine room on the left, and the boiler room and distillation equipment buildings on the right.

Marshall Gasoline Plant Something Different

By J. C. ALBRIGHT

WHEN various subsidiary companies, including Roxana Petroleum Corporation, were incorporated into the Shell Petroleum Corporation, this company built a gasoline recovery plant in the Marshall field, northern Logan County, Oklahoma, that in the final disposition of the various cuts of petroleum hydrocarbons, was something different in the natural gasoline industry.

This field has deeper production than most fields which were in operation at the time of the discovery of petroleum in the north Logan County area. Deep well pumping has not at the present time been successful enough to warrant the general equipping of all the individual wells with this most expensive and difficult method of producing oil from great depths. The stresses incidental to swinging over 6000 feet of tubing with the string of sucker rods and working barrel, presents a problem yet to be solved.

Due to this fact, most of the operating companies in the Marshall field were content to permit their wells to flow of their own head pressure, or failing this, they swabbed them when the production fell below the number of barrels that they had a right to expect.

The attendant casing head gas present with the oil, possesses all of the lower boiling fractions of petroleum vapor, from methane on up the scale to the heavier residuum in the fluid oils. Being cognizant of these conditions, Shell Petroleum Corporation installed a natural gasoline recovery plant designed to utilize all of the various cuts encountered in the manufacture of ordinary gasoline as produced in the Mid-Continent.

In laying out the lines from the field, company engineers designed the system in such a manner that the gas enters the plant yard from both the south and the north ends through 16-inch delivery lines to the compressor intake header. At the junction of the delivery lines to the intake header there are placed two pressure controlling valves, built with a standard by-pass.

The valves are 16-inch Fisher, balanced, pilot operated. One of them being at the north end of the engine room and the other one some distance from the south end of the building, almost directly in front of the gasoline plant office. Under the operating conditions which were encountered in this field, the installation of these valves was made necessary due to the fluctuating delivery of the casing head gas from the flowing and swabbing wells. With these valves in operation, the gas intake to the compressors can be held at almost constant pressure. Without these valves, the gas coming into the compressors in heads, would overload the engines at times, and between flows, or periods of swabbing, there would be a relatively high vacuum on the header.

The engine room is equipped with eight twin Miller gas engine driven Watts-Miller compressors. Each twin

has its own individual hot well, or receiving tank for the cooling water. Each engine is also equipped with individual belt-driven centrifugal pumps to handle its own water to the cooling towers. These individual concrete hot wells are placed just outside the engine room, on the compressor side. The pits have a communicating flume connecting all in a common system. Should one of the individual pumps fail, or shut down for any reason, there is no loss of water, as the pit without the pump in operation will overflow into the ones on both sides of it. On the discharge pipe leading from each of these pumps, there is placed a Fisher, balanced back pressure valve with the operating arm connected by a chain to a float placed in the hot well. This arrangement prevents the water being pumped below a predetermined level. This level is a short distance above the suction foot valve, consequently the pumps are never found to be air bound.

The engine room roof is equipped with gutters, with the down spouts leading to these hot well pits, permitting their supply of cooling water to be augmented by the natural rainfall. At most other gasoline plants this soft water is almost invariably permitted to run around, and sometimes through, the buildings to a drain in the yard and consequently wasted. All of the individual drive belts, as well as the pumps themselves are covered with hardware cloth, securely fastened to a heavy angle iron frame surrounding the equipment in motion.

GAS CIRCUIT

Each compressor cylinder discharges its load of gas through individual Southwestern tubular enclosed gas coolers, entering at the bottom and leaving at the top connection. The intake and discharge pipes connected to the compressors leave the building under the floor. Each line has an individual gate controlling operation, placed near the floor. The interior of the engine room presents a very pleasing picture: the visitor remarking on the absence of pipes leaving through the roof or engine room walls. This arrangement enables the operators and the repair forces to work on an engine unhampered.

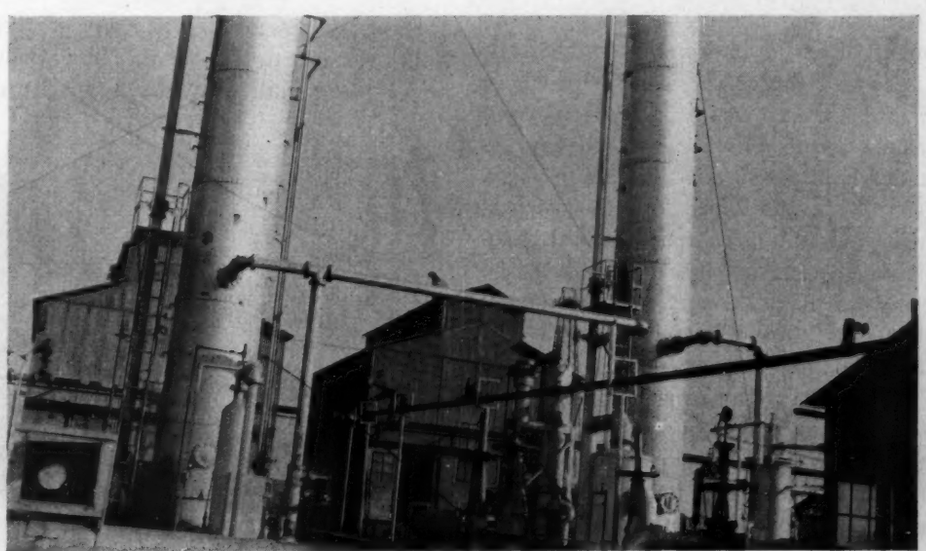
The company has had built a hoist frame with an "I" beam securely fastened to a heavy plate, under which, at each end of the beam, are placed legs, having a heavy plate welded to the lower ends, under which are fastened heavy casters. The operators may move this piece of equipment, having a chain hoist attached to the "I" beam with a travelling arrangement, anywhere within the room and over any part of the individual engine. This equipment facilitates repairs by allowing a cylinder, piston or engine head to be moved from its operating position to the repair benches.

Leaving the coolers, the gas passes down through a pipe, having another control valve placed in the line, to a common discharge header, thence to the absorbers. These absorbers were fabricated to the specifications of the engineers of Shell Petroleum Corporation, and were designed to extract under predetermined operating conditions, all of the desired fractions of the gas in process. They may be operated either in series or in multiple, depending upon the quality and quantity of the gasoline the management desires to manufacture.

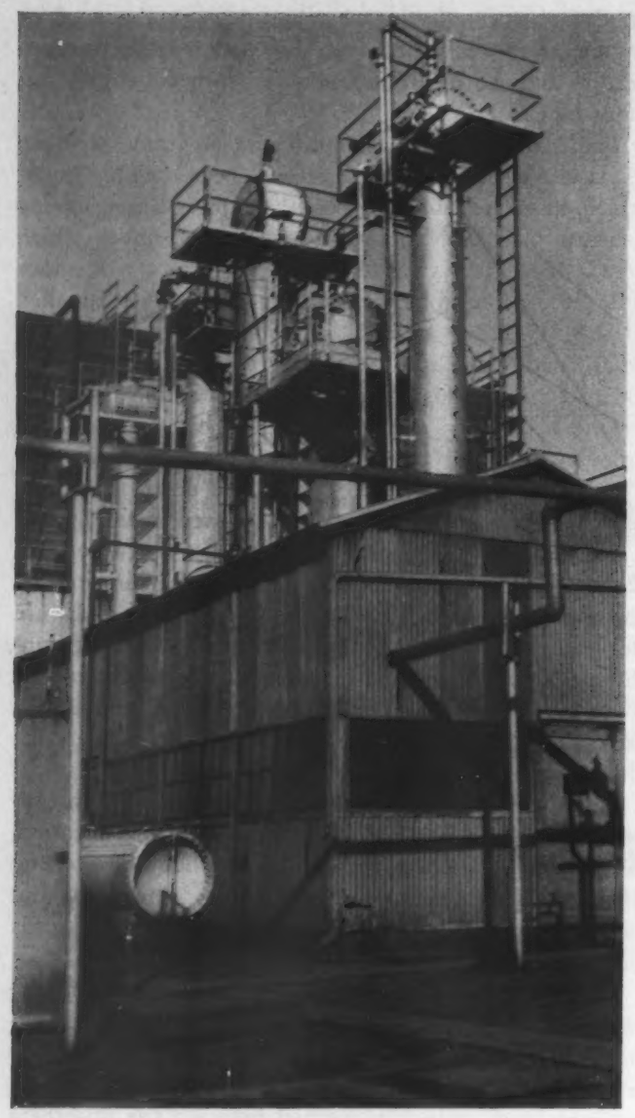
The distillation units are two in number, being manufactured by the Southwestern Engineering Corporation. These are enclosed in a suitable steel building housing all the equipment appertaining thereto. The water and oil circulating pumps are also placed within this building.

The gasoline vapors, after being distilled from the mineral seal oil, are carried over and through a knock-out section to the dephlegmator, where the heavy ends are trapped through an Armstrong trap to the fat oil, or surge tank, which is located between the absorbers and the rich oil pumps—returning in the stream to stills.

Upon leaving the dephlegmator, vapors pass directly



The absorbers at Shell Petroleum Corporation's Marshall Gasoline Plant. Showing the hook-up for operation in series or multiple.



Battery of Fractionators

to the Southwestern enclosed gasoline vapor condensing units, placed in the building housing all of the other distillation equipment. Leaving the condensers, the condensed gasoline is passed through a water leg, where all the carry over of condensed steam is separated from the gasoline stream. From this leg, the gasoline is passed directly under still pressure to the raw storage.

A market having been developed for the various products that can be manufactured from natural gasoline, Shell Petroleum Corporation has taken advantage of the situation, and has installed sufficient equipment with which it can manufacture any one or several different kinds of material that have been on the market for some time. With this fractionating equipment, the company manufactures in large quantities propane, which is called Shellane, varying in purity according to the period of the year in which it is marketed, and the locality to which it is sent for distribution. In the summer months and in the late fall, if Shellane is marketed in the southern states, the almost pure propane may contain a small fraction of butane. The warmth of the south and of the summer weather in the northern states, being favorable to the complete vaporization of the heavier fractions present when butane is permitted to remain in the liquefied propane.

Butane is becoming a favored fuel in the operation of isolated power plants. The pump stations of some of the pipe line companies are being equipped to use butane as the principal fuel to furnish power generated by these converted gas engines. Properly operated, natural gasoline fractionators may be caused to cut the butanes practically pure from the gasoline in process.

Cigar and cigarette smokers have the gasoline manufacturers to thank for the efficient manner in which their "lighters" have been operating in the past year. Occasionally an entire standard car load of this lighter fluid is moved to the principal centers of population for distribution. This fluid is manufactured in this plant, and for the benefit of the man who says: "My lighter will light nine times out of 10."

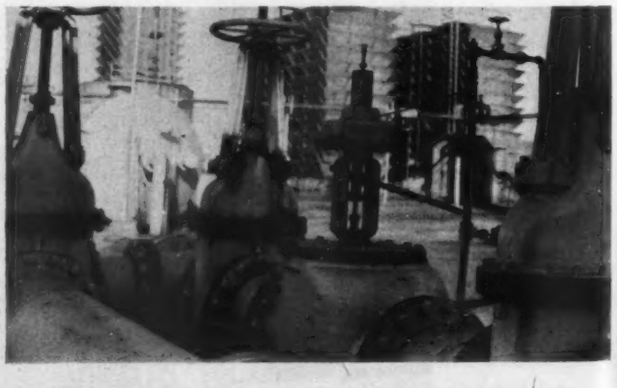
The automobile driver and the truck fleet operators may be using a product, or rather the results of a product that is manufactured in the Marshall plant of Shell Petroleum Corporation. The rubber manufacturers in the processing of raw rubber to the finished article, in several steps need and use a solvent taken from natural gasoline by the intelligent operation of the fractionation equipment in this plant.

The paint and lacquer industries consume large amounts of synthetic turpentines, and the lacquer industry in particular uses as a vehicle a product manufactured from natural gasoline. It is also used as a thinner for their products.

Previous to the time that proration was applied to the field adjacent to this plant, there was a normal production of 50,000 gallons of AA natural. All of which was passed through the fractionation equipment to stabilize it to the required grade for shipment.

CARE OF STEAM PLANT

Steam is generated by the use of five 80-horsepower Southwestern Collins water tube boilers placed in a boiler room built near the main entrance gate to the



Field intake pressure regulator. Fisher pilot operated pressure regulator. Crane rising stem gate valves in setting.

plant. These boilers are taken off the line as necessity demands, cooled to a temperature which may permit a workman to enter the drums where he operates a suitable water driven rotary cleaning device to remove the accumulated scale adhering to the inside of the tubes.

In this cleaning operation, the apron covering the tube cap sheet is lowered, supported by chains fastened to each outer corner and to suitable hooks on the boiler frame above forming a convenient platform upon which the operator may stand while at work. All of the manhole plates are removed from the boilers, cleaned, and new gaskets applied before reinstallation in the boiler. The small tube caps in the cap sheet are removed from the apertures closed by the master caps.

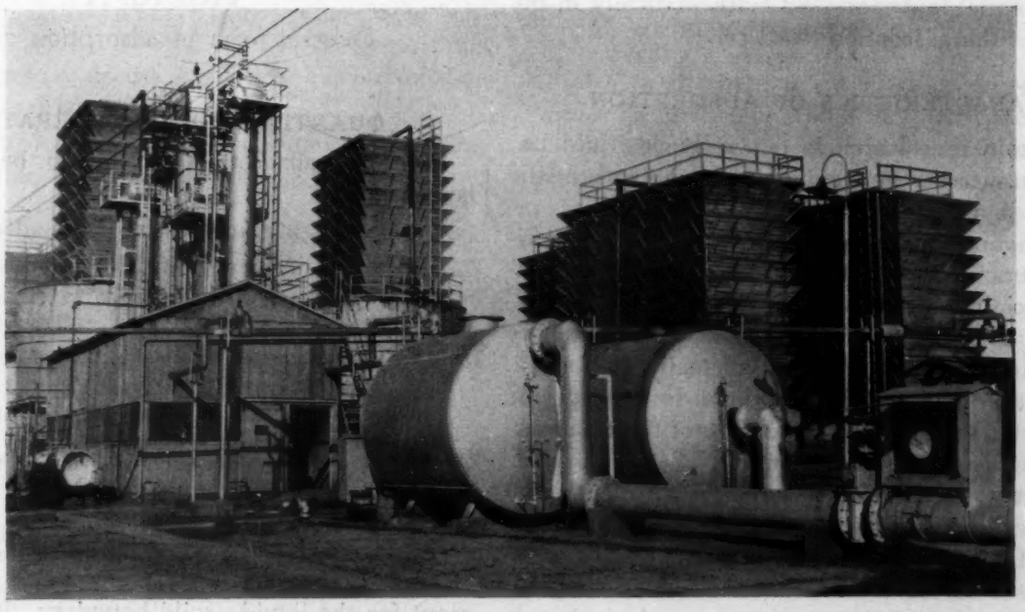
After removal, one of the operators on the cleaning out process polishes the outer side of these caps while another operator is cleaning the inside of the boiler tubes with a Lagonda or some similar drill. After the drilling-out operation is completed, the chief engineer inspects the tubes to ascertain whether all scale has been removed. The tube cap holes are then polished with Aloxite cloth or with some other abrasive, and the tube caps inserted. While this operation is being completed, one of the men has taken the valve from the non-return valve body, and has cleaned all of the incrustation from the seat and apertures. After putting this valve back into the body, he replaces the valve body bonnet only after a new bonnet gasket has been placed in the groove milled into the valve body.

The boiler is now ready to be filled with water. The blow-off valves are closed, and water pumped into the boiler to the usual level, the pilot lights are lighted, the fuel turned on through the Perfecto burners, and usually after a couple of hours the steam has risen to sufficient pressure to determine what leaks, if any, appear around the tube caps. If a leak occurs, the operator, using a light hammer—about a ¾-pound one—gently taps the tube cap sheet surrounding the cap, gradually bringing the cap and sheet in contact close enough to close the leak. After all the leaks have been stopped in this manner, the apron is drawn back to its place against the boiler front and secured against falling. Usually during this tapping operation, the boiler has generated enough steam to bring the pressure high enough to enable the operator to "cut over" and place in service.

Water for boiler use is prepared by first filtering through a Graver Corporation water filter with an alum coagulator. The water is pumped to this filter through a venturi tube, to which is connected the lines leading to and from the alum pot. Sufficient alum impregnated water is drawn through the pot through the action of the venturi tube to effect settling of all colloidal or suspended matter. After leaving the filter, the water is directed to the boiler hot well through a preheater.

The main steam lines, as well as the lateral delivery lines, are all insulated, with suitable condensation traps placed at well located positions. The steam delivered to the pumps and other equipment is relatively free from water. All the condensed steam is returned to the boiler feed tank, excepting that from the oil preheaters which is passed through Armstrong traps to a condensing pump and fed directly to the boilers ahead of the water level control valves.

A great amount of water is necessary in this plant. An illustration with this article shows six of the eight louvre towers needed to secure proper cooling of the plant water used in cooling the engines, power and compressor cylinders, the oil, gas and the condensers on the fractionator heads.



Shell Petroleum Corporation's Marshall Gasoline Plant, showing field scrubbers, with Robinson Orifice meter fitting on intake. Cooling towers in back ground, and fractionator equipment at left.

Notes on Adsorption

By HAROLD J. TORMEY
Professor of Chemistry, St. Bonaventure College

SINCE the principal action of clay in the clarification of oil is one of adsorption it may be of interest to consider some of the pertinent bits of information the physical chemist has unearthed concerning this process.

By adsorption in solution—that is the only type here being considered—is understood to mean the increase in concentration of a dissolved substance in the layer of liquid bounding the solid surfaces, the so-called boundary layer.

The increase in concentration of a dissolved substance in the boundary layer may be brought about by formation of a loose chemical complex or by physical forces. In either case the attraction between positive and negative charges plays an important part.

The adsorption of non-electrolytes is in general similar to the adsorption of electrolytes although the former is closely related to surface tension lowering while the latter is attended by electrical phenomena of considerable importance. The term non-polar adsorption is usually applied to adsorption of non-electrolytes while the term polar adsorption is applied to the adsorption of electrolytes.

Notwithstanding the differences between the two types of adsorption both processes appear to follow the exponential law expressed mathematically in the equation of the adsorption isotherm.

CHARACTERISTICS OF ADSORPTION

Adsorption in solution is generally positive; i.e., there is an increase of the dissolved substance in the boundary layer.

The amount of positive adsorption may be sufficient to remove nearly all of the solute from the solution, especially if the solution is dilute.

In case of negative adsorption—decrease of solute in boundary layer—the amount is usually very small.

Adsorption is directly proportional to the "specific surface" this term meaning the ratio of the total surface of an adsorbent to its volume.

Adsorption in solution is largely dependent upon the surface tension of the solvent, the greatest adsorption for the same solute occurring in that solution whose solvent has the highest surface tension.

The influence of temperature on adsorption is usually very small. In most cases the adsorption is somewhat greater at lower temperatures and smaller at higher temperatures. In this connection it might be noted that boundary tensions usually decrease with rising temperatures.

A substance that is easily adsorbed in usually a poor adsorption medium. This indicates the reason for the readiness with which an adsorbed substance can often be removed from the adsorbent by washing it with a liquid that is well adsorbed.

Adsorption is slight for inorganic substances except halogens.

Salts of heavy metals are adsorbed to a greater extent than salts of alkali metals.

Adsorption is strong for aliphatic compounds and halogens.

Adsorption is strongest for aromatic substances.

The more benzene nuclei present and the greater the complexity of the molecular structure the greater the adsorption.

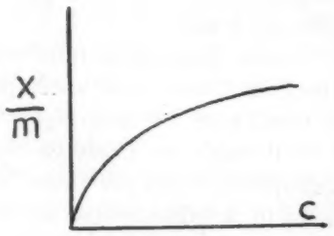


FIGURE A
General form of adsorption curve

QUANTITATIVE CONSIDERATIONS

Non-polar adsorption appears to be conditioned largely by—

(a) the specific surface of the adsorbent;

(b) the influence of the substance to be adsorbed on the boundary tension.

$$\frac{d\Delta}{dc}$$

Since $\frac{d\Delta}{dc}$ varies for different substances it is evident that a large surface will not in itself assure a large amount of adsorption.

Neither Δ or $\frac{d\Delta}{dc}$ is susceptible to direct measurement for the liquid—solid boundary. In some cases, it is compared with its corresponding value for the liquid-gas equilibrium. This comparison is hardly permissible, although substances showing great sur-

face activity under one set of conditions are frequently well adsorbed under other conditions.

The facts so far noted find a quantitative expres-

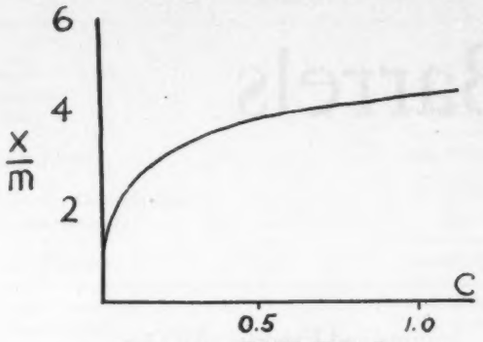


FIGURE I

Adsorption of succinic acid by charcoal

sion in the empirical equation of Freundlich known as the adsorption isotherm.

$$\frac{x}{m} = k.c \frac{1}{n}$$

x total amount adsorbed
m amount of adsorbent used
c equilibrium concentration
k constant
n constant

Assuming a simple type of adsorption the following equation of Langmuir can be deduced:

$$\Gamma = \frac{\propto c}{B + \frac{\propto c}{Z}}$$

Γ = adsorbed quantity. Z = limits of adsorption. $\propto$, B = constants.

By plotting the amounts adsorbed against equilibrium concentrations a curve of the general type represented in Figure I is obtained. If the logarithms of these values are used a straight line is obtained as represented in Figure II.

The general form of the adsorption curve indicates that absorption is greatest in dilute solutions.

The quantity $\frac{1}{n}$ is of little specific character as is indicated by the fact that the logarithmic curves for a number of different solutes removed by the same adsorbent are straight lines which are roughly parallel and hence have the same slope.

Studies on the adsorption of acetic acid by charcoal at various temperatures show that the "k" of the adsorption isotherm decreases with rising temperature while $\frac{1}{n}$ increases slightly.

The equation of Langmuir gives more of the curve than does the adsorption isotherm of Freundlich but even although these equations hold well in some cases there are a number of cases in which the equations do not hold. It seems probable that the failure of the equations to agree with the experimental results in certain cases is due to the fact that the equations assume a single type of adsorptive action of simple nature whereas there are probably a number of types of adsorptive forces of varying complexity operating in such cases.

Equilibrium is rapidly attained in most adsorptions. In cases where equilibrium is slowly reached it seems probable that the adsorptive reaction is not simple. In a number of such cases it has been found that the adsorption is followed by a chemical reaction.

Most of the evidence seems to indicate that the adsorption process is an equilibrium reaction thus necessitating the presence of some unadsorbed molecules of solute in solution even although in such cases as the adsorption of certain dyes from solution the dye appears to be completely removed.

Equilibrium considerations contraindicate complete adsorption as a limiting case but nevertheless the adsorption curve shows a limiting value. One explanation of this limiting value—other than a limiting value by reason of complete adsorption—has been offered by Langmuir and is discussed under the mechanism of adsorption.

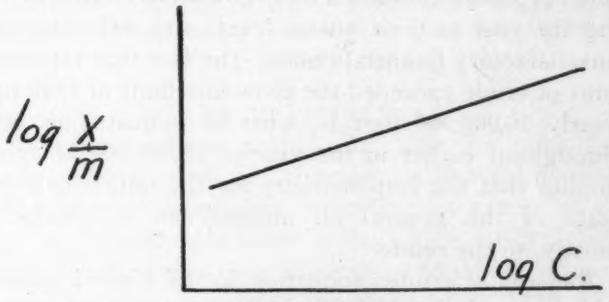


FIGURE II

Adsorption of succinic acid by charcoal

MECHANISM OF ADSORPTION

Since equilibrium conditions for the solid-gas equilibrium can be determined directly from the gas pressure thus doing away with the necessity for an analytical determination of concentration, various problems of general interest in the study of adsorption have been carefully worked out for this equilibrium. The investigations of such equilibria by Langmuir led him to propose a kinetic basis for adsorption.

Langmuir represents the adsorbent by a crystal lattice in the interior of which all valences are saturated while on the surface there are regularly distributed unsaturated valences. It is these unsaturated valences which are presumably responsible for the adsorption. Gas molecules penetrating the sphere of attraction of these unsaturated valences are adsorbed but tend to escape due to their kinetic energy which acts in an opposite direction. Thus there is simultaneous condensation and evaporation on the surface;

(*Continued on page* 136)

Runs This Year Should Be 913,865,000 Barrels

By H. J. STRUTH
Staff Economist

SELDOM in its history has the petroleum industry achieved the degree of economic production control that accompanied its developments during last year. A review of the oil situation from every angle points definitely to a better general understanding and recognition of the workings of the economic law of supply and demand.

The year closed with production of crude in theoretical balance with market requirements, while refinery runs had been curtailed to the extent of reducing an earlier indicated excess of about 83,000,000 barrels to an actual excess of but 16,000,000 barrels. Despite this achievement, prices of crude oil and refined products continued their downward trend, closing the year at their lowest levels and reflecting an unsatisfactory financial result. The fact that refinery runs of crude exceeded the economic limit of 1930 by nearly 16,000,000 barrels, with an indicated excess throughout earlier in the year of 83,000,000 barrels, implies that the responsibility for the unsatisfactory state of the general oil market can be charged, mostly, to the refiner.

Records of crude production in the United States point to an almost uninterrupted downward trend during last year, having prescribed a decline from the beginning to the end of that period of about 575,000 barrels a day.

Highlights of the Oil Situation During 1930

		Increase Over 1929	Decrease Under 1929
World crude oil production..bbls.	1,412,500,000	.....	71,951,000
U. S. crude oil production...bbls.	909,000,000	.....	98,323,000
Total crude oil demand.....bbls.	983,088,000	.....	66,076,000
Refinery crude runs.....bbls.	928,000,000	.....	59,000,000
Crude imports .....bbls.	62,000,000	.....	16,933,000
Crude exports .....bbls.	24,000,000	.....	2,401,000
Wells drilled	19,848	.....	3,615
Oil wells completed.....	10,745	.....	2,380
Initial Oil Production.....bbls.	10,443,863	4,039,618	.....
Crude oil stocks Dec. 31.....bbls.	516,851,000	.....	12,088,000
Average value of crude per bbl.	$.90	.....	$.20
Domestic gasoline demand...bbls.	395,466,000	19,467,000	.....
Gasoline exports .....bbls.	65,296,000	3,237,000	.....
Gasoline imports .....bbls.	17,000,000	8,166,000	.....
Motor Vehicle Registrations December 31, 1930.....	26,800,000	298,557	.....
Value of motor gasoline per gal.	$.0696	.....	$.0152
Gasoline stocks Dec. 31.....bbls.	37,499,000	.....	5,762,000
Stocks of all oils.....bbls.	672,000,000	.....	10,069,000

Table 1

Imports and Exports—All Oils

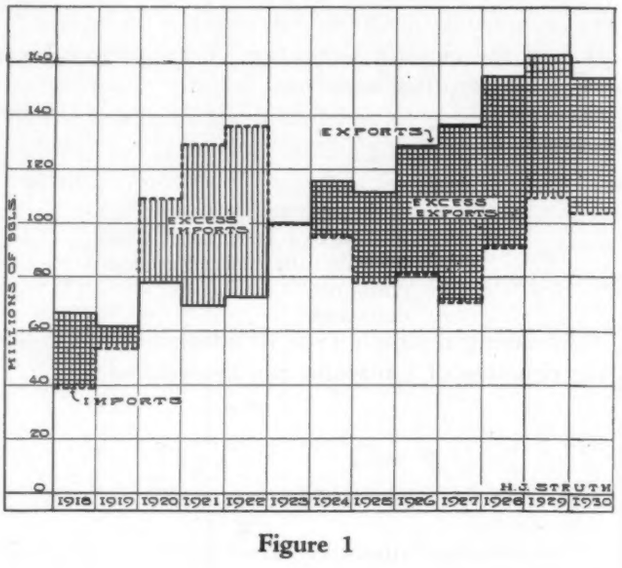


Figure 1

In the refining branch of the industry, however, runs to stills continued to show an upward trend during the first half, at a rate considerably above market requirements for gasoline, reaching a peak during that period of 2,786,000 barrels daily. Subsequent market developments led to a concerted effort at curtailment. While progress was made in this direction during the last half of the year, it became apparent that increased cracking facilities, and a slackened rate of demand, necessitated even more drastic curtailment. This realization came too late to effect a turn in the ebbing tide of market values, with the result that prices became further depressed and crude values were forced to a corresponding low level.

Table 1, Highlights of the Oil Satuation During 1930, shows what was accomplished. Crude production was curtailed 98,323,000 barrels during 1930, whereas all other oil producing countries of the world registered a combined gain of about 27,000,000 barrels. Also on the favorable side of the picture is a decline of 66,076,000 barrels in total crude demand, of which about 59,000,000 barrels represents curtail-

U. S. Gasoline Situation
1929—1930
(Barrels)

	1929	1930
Stocks, January 1	33,066,000	43,261,000
Production	439,393,000	438,000,000
Imports	8,834,000	17,000,000
Total Supply	481,293,000	498,261,000
Domestic Consumption	375,999,000	395,466,000
Foreign Demand	62,059,000	65,296,000
Total Demand	438,058,000	460,762,000
Stocks, December 31	43,261,000	37,499,000
Added to Stocks	10,195,000	.....
Withdrawn from Stocks	.....	5,762,000

Table 2

ment of refinery runs to stills. Crude imports showed a favorable decline of 16,933,000 barrels; crude stocks declined over 12,000,000 barrels; gasoline stocks were drawn upon to the extent of about 5,762,000 barrels; and stocks of all oils declined 10,069,000 barrels.

At the same time the demand for gasoline showed a total gain over 1929 of 22,704,000 barrels—not as large a gain as in 1929 to be sure—but, nevertheless, a gain during a year of general depression. On the unfavorable side are, a gain in initial crude production from new wells drilled; an untimely gain in gasoline imports of more than 8,000,000 barrels, a lesser demand for American crude from foreign sources; a decided slump in the annual rate of increase in motor vehicle registrations; and severely depressed market values of crude oil and gasoline.

GASOLINE SITUATION

Table 2 shows what happened in the gasoline situation last year, in comparison with 1929. As a result of increased importation, the total supply showed a gain over 1929 of nearly 17,000,000 barrels, while demand had increased less than 23,000,000 barrels, with a handicap of excessive stocks of 10,000,000 barrels with which to begin the year.

Table 3 shows how much crude should have been run each month by refineries in the United States, in order to meet the demand for gasoline as well as eliminate excessive stocks of this product. While the total gasoline demand for 1930 was approximately 460,255,000 barrels, it is seen that 66,616,000 barrels of this quantity represents natural gasoline, benzol and imported gasoline. In addition, it was considered necessary for the industry to reduce stocks of gasoline to the extent of about ten million barrels, leaving a net quantity of gasoline to be produced from crude oil of 383,639,000 barrels. At an average yield of 42.2 per cent, this quantity of gasoline should have required the processing of nearly 912,000,000 barrels of crude. Actually, the industry ran to stills about 928,000,000 barrels, or an excess of nearly 16,000,000 barrels. This excess quantity of crude run to stills represented a production of 6,663,000 barrels of gasoline. Had runs to stills been maintained at the indicated normal rates prescribed, stocks of gasoline at the end of 1930 would have amounted to but 32,337,000 barrels, instead of about 39,000,000 barrels. This quantity of excessive gasoline, therefore represents the difference between prosperity and adversity; as exemplified by the actual results of last year.

Normal and Actual Refinery Runs—1930
(Thousands Barrels)

	Total Gasoline Consumption	Natural Gasoline Benzol and Imports	Necessary Stock Changes	Net Gasoline From Crude	Average Yield %	Normal Crude Runs	Actual Crude Runs
January	31,172	5,077	—0.5	25,595	40.4	63,353	80,163
February	31,349	4,705	—0.5	26,144	41.4	63,149	72,414
March	37,086	5,284	—1	30,802	41.8	73,688	80,252
April	40,280	5,560	—1	33,720	41.9	80,477	80,434
May	41,450	5,707	—1.5	34,243	42.0	81,530	83,647
June	43,028	5,784	—2	35,244	41.1	85,751	80,747
July	43,950	6,140	—3	34,810	42.6	81,713	78,644
August	44,124	6,065	—3	35,059	42.1	83,275	79,289
September	41,852	5,766	—2	34,086	42.8	79,640	75,950
October	38,590	6,197	+1	33,393	44.2	75,540	74,016
November	34,374	5,281	+1	30,093	41.7	72,165	70,310
December	33,000	5,050	+2.5	30,450	42.5	71,640	71,920
Total	460,255	66,616	—10	383,639	42.2	911,921	927,786

Table 3

TOTAL EXPORTS

Figure 1 shows graphically how the industry's total exports of all oils compares with total imports. The cross-hatched area indicates the excess of exports, or balance in favor of the United States, while the ribbed area shows the extent to which imports exceeded exports during the three years, 1920, 1921 and 1922. The year 1923 showed an even break between exports and imports. While the area of excess exports over imports became somewhat narrower during 1930, the fact remains that the balance is still in favor of the United States. How long this will continue to be so is conjectural, however, since imports of gasoline showed such a material gain last year, while exports were considerably below the ex-

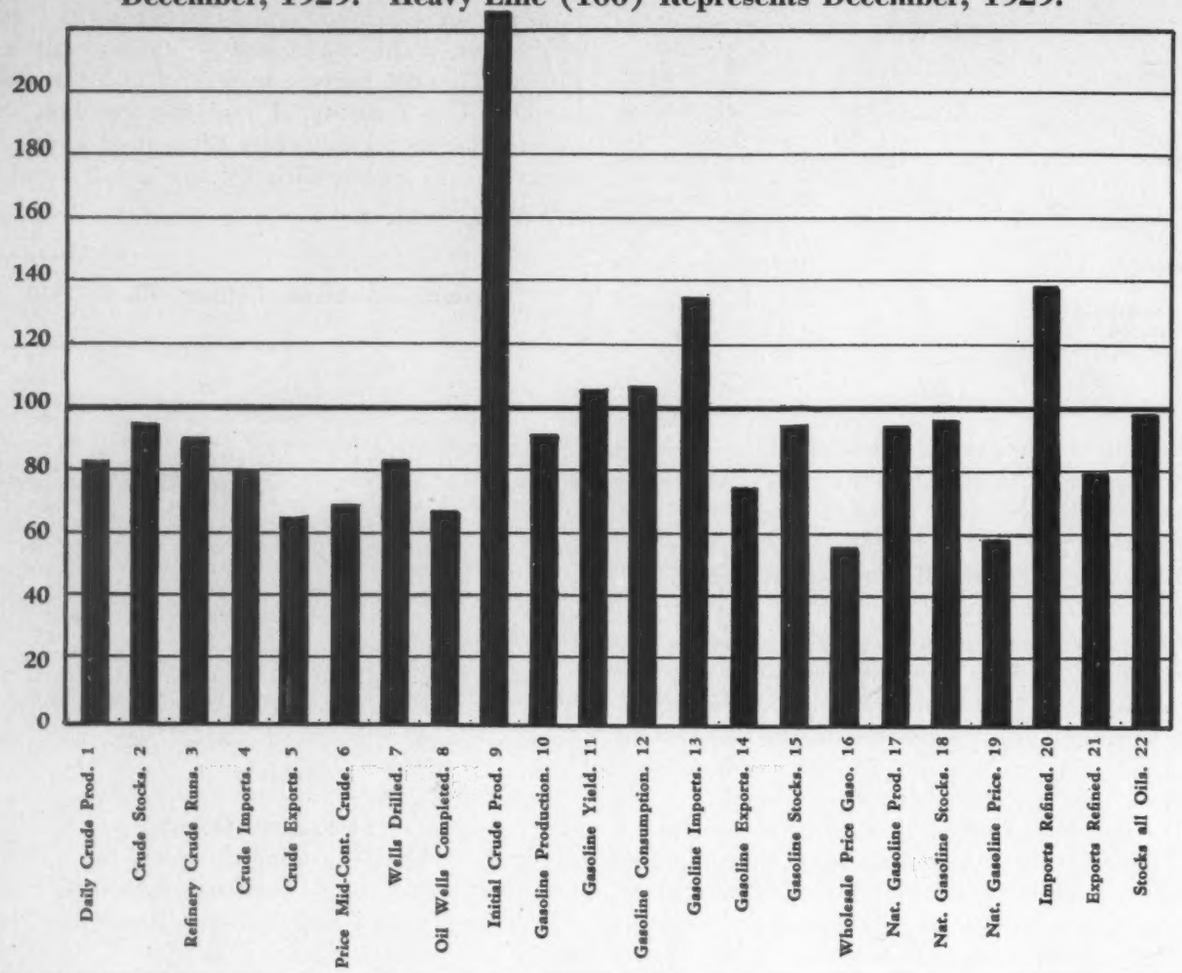
1931 Supply and Demand Outlook Compared With Last Year

	1930 Actual	1931 Estimated	Per Cent of 1930
Total Crude Demand	966,000,000	945,000,000	98
Domestic Crude Production	909,000,000	850,000,000	93
Crude Imports	62,000,000	60,000,000	97
Total Refinery Runs	928,000,000	914,000,000	98
Domestic Gasoline Demand	395,000,000	408,000,000	103
Gasoline Exports	65,000,000	70,000,000	107
Gasoline Imports	17,000,000	13,000,000	76
Gasoline Production*	440,000,000	420,000,000	95
Gasoline Yield (Per Cent)	42.2	44.5	105

*Including Natural Gasoline and Benzol.

Table 4

Salient Oil Industry Factors for December, 1930, Expressed in Per Cent of December, 1929. Heavy Line (100) Represents December, 1929.



Oil Industry Barometer

Index of Salient Factors—Current and Cummulative, December, 1930

	Factors—	This Month Last Year	This Month This Year	This Month Index (a)	12 Months Ending Dec. 31 Last Year	12 Months Ending Dec. 31 This Year	12 Months Ending Dec. 31 Index (a)
1	Daily Average Crude Production (Thous. Bbls.)	2,610	2,161	83	2,760	2,456	89
2	Total Crude Stocks (Thous. Bbls.)	540,851	512,797	95	540,851	512,797	95
3	Refinery Crude Runs (Thous. Bbls.)	80,663	71,581	89	987,708	927,447	94
4	Crude Imports (Thous. Bbls.)	5,886	4,727	80	78,933	62,129	79
5	Crude Exports (Thous. Bbls.)	2,089	1,339	64	26,401	23,706	90
6	Posted Price 36 Gravity Mid-Continent Crude (Bbl.) (b)	$1.45	$ .95	66	$1.36	$1.21	89
7	Wells Drilled*	1,791	1,479	83	23,463	19,356	82
8	Oil Wells Completed*	978	650	66	13,125	10,512	80
9	Initial Crude Production* (Thous. Bbls.)	433	979	226	6,404	9,804	153
10	Gasoline Production (Thous. Bbls.)	37,734	34,352	91	439,393	441,534	100
11	Gasoline Yield—Average Per Cent of Crude (d)	41.08	42.95	105	39.19	42.03	107
12	Domestic Gasoline Consumption (Thous. Bbls.)	27,181	29,094	107	375,999	395,560	105
13	Gasoline Imports (Thous. Bbls.)	716	964	135	8,834	16,927	192
14	Gasoline Exports (Thous. Bbls.)	6,005	4,386	73	62,059	65,621	106
15	Gasoline Stocks at Refineries (Thous. Bbls.)	43,261	40,541	94	43,261	40,541	94
16	Refinery Price U. S. Motor Gasoline, Group 3 (Cents) (c)	7¼	4	55	7.7	6.3	82
17	Natural Gasoline Production (Thous. Bbls.)	4,457	4,198	94	52,271	51,736	99
18	Natural Gasoline Stocks (Thous. Bbls.)	604	578	96	604	578	96
19	Price Grade "A" Natural Gasoline, Group 3 (Cents) (c)	6⅝	3¾	57	7	5½	78
20	Imports all Refined Oils (Thous. Bbls.)	2,403	3,310	138	29,777	43,486	146
21	Exports all Refined Oils (Thous. Bbls.)	12,321	9,727	79	136,719	132,960	97
22	Total Stocks all Oils (Thous. Bbls.)	689,166	665,870	97	689,166	665,870	97
	Weighted Index of Supply	.....	.....	111	.....	.....	82
	Weighted Index of Demand	.....	.....	112	.....	.....	98
	Weighted Index of Prices	.....	.....	59	.....	.....	83

*Exclusive of Rocky Mountain area.
(a)—Last Year—100.
(b)—Weighted Average.
(c)—Monthly Average.
(d)—Straight run and cracked gasoline only.

Preliminary Survey of 1931 Gasoline Demand and Crude Requirements

	Thousands of Barrels
Domestic Gasoline Demand	408,056
Foreign Gasoline Demand	70,289
Total Gasoline Demand	478,345
Natural Gasoline and Benzol	58,000
Net Gasoline from Crude	420,345
Imported Gasoline	*13,000
Net U. S. Refinery Gasoline Demand	407,345
Crude Required at average yield of 44.5 per cent	915,000
Probable Imports of Crude	60,000
Domestic Crude Required by Refineries	855,000
Crude Exports and Other Consumption	31,000
Grand Total Domestic Crude Required	885,000

*Limit—if curtailment is applied in South America, as anticipated.

Table 5

pected demand from foreign sources. In this connection, it would appear logical to conclude that the building of foreign refineries has already made serious inroads upon the industry's foreign markets, and additional units now being built are expected to bring about a further slump in foreign demand for gasoline and other petroleum products. In fact, under the present foreign line-up, including the aggressive tactics being pursued by the oil industry of Russia, there is every reason to believe that the future of the industry's foreign oil markets is hazy indeed. Another angle to this situation is the effect that a tariff would have upon imported petroleum and its products. Naturally, whatever quantities of oil are now being brought into the United States would, under an import duty, be diverted into foreign channels. In the long run, this will mean the eventual dissipation of America's foreign oil markets. Nevertheless, it is evident that something must be done to prevent the influx of foreign oil into an already glutted American market if the forces of production control here are to achieve complete success.

REFINERIES WILL NEED 914,000,000 BARRELS

The accompanying Table 4 shows what the industry can expect in the way of demand for both crude and gasoline this year, and shows the figures for each of the important supply and demand factors and their percentage relation to the records of last year. Based upon an expected increase in gasoline demand of three per cent over last year, it has been determined that refinery runs should not exceed 914,000,000 barrels, or a daily average of 2,504,000 barrels. Imports of gasoline should be limited to not more than 13,000,000 barrels, 24 per cent less than last year, and refinery operating schedules should be worked out accordingly. Another factor that has an important bearing upon this year's crude demand is the increased recovery of gasoline from crude. The expected yield of gasoline from crude for 1931 will be approximately 44.5 per cent, a gain of 2.3 per cent and a relative increase over last year of about five per cent. The foreign demand for gasoline this year is not expected to show a gain of more than seven per cent over 1930, a total increase of only 5,000,000 barrels.

Gasoline Demand—1931
(Thousands of Barrels)

	By Motor Vehicles	Misc. Cons.	Exports	Total	Cumulative
January	20,982	4,012	5,882	30,876	30,876
February	21,347	3,814	5,217	30,378	61,254
March	26,125	4,488	6,529	37,142	98,396
April	27,112	4,993	6,177	38,282	136,678
May	31,268	5,720	5,338	42,326	179,004
June	32,358	5,834	6,034	44,226	223,230
July	33,760	5,918	7,590	47,268	270,498
August	34,020	6,034	7,212	47,266	317,764
September	32,644	5,609	7,138	45,391	363,155
October	29,658	5,272	4,343	39,273	402,428
November	28,643	5,020	3,979	37,642	440,070
December	28,518	4,907	4,850	38,275	478,345
Total	46,435	61,621	70,289	478,345	.....

Table 6

Basis for Projecting Refinery Runs, 1931

	Total Gasoline Demand	Imports, Natural Gasoline and Benzol	Net Gasoline from Crude	Course of Stocks	Per Cent Yield	Crude Runs Required	Daily Average
January	30,876	4,581	26,295	+3	42.87	68,334	2,204
February	30,378	4,507	25,871	+1.5	42.97	63,697	2,275
March	37,142	5,511	31,631	+3	43.53	79,556	2,566
April	38,282	5,680	32,602	— .5	43.59	73,645	2,455
May	42,326	6,280	36,046	—1.5	44.25	76,940	2,482
June	44,226	6,770	37,456	—2	44.36	79,927	2,664
July	47,268	6,819	40,449	—3	44.54	84,079	2,712
August	47,266	7,025	40,241	—3	44.62	83,462	2,692
September	45,391	6,321	39,070	—2	44.73	82,875	2,673
October	39,273	6,242	33,031	+1	44.76	76,029	2,453
November	37,642	5,585	32,057	+1	46.55	71,013	2,367
December	38,275	5,679	32,596	+2.5	47.23	74,308	2,397
Total	478,345	71,000	407,345	0	44.50	913,865	2,504

Table 7

Table 5 summarizes the 1931 gasoline demand and shows the normal quantity of crude that will be required to produce a normal gasoline supply. This year's gasoline demand is based upon a probable average motor vehicle registration of 27,650,000, assuming that the total registration on January 1 was about 26,800,000. On a percentage basis, the total demand for gasoline will exceed last year's total by only 3.94 per cent, while the domestic demand will only amount to a gain of 3.18 per cent over 1930. Exports may show a gain over last year of 7.65 per cent. Some idea of how this year's gasoline requirements will be spread over each month can be gained from the data shown in Table 6. This shows the quantity expected to be consumed by motor vehicles, miscellaneous domestic consumption, exports and total, as well as the cumulative total to date. This data is in turn expressed in terms of crude requirements in Table 7, showing the total monthly gasoline demand, the quantity of gasoline contributed by imports, natural gasoline and benzol, as well as the normal course of stocks. On the assumption that the yield of gasoline from crude will continue to show a steady increase this year, culminating in a maximum yield of over 47 per cent, with an annual average of 44.5 per cent, it is seen that refinery crude requirements will amount to 913,865,000 barrels, or a daily average of 2,504,000 barrels.

REFINER
AND NATURAL GASOLINE
MANUFACTURER

EDITORIALS

WHAT the petroleum industry needs today is a larger laboratory and a research program focused to look beyond the automobile. The chemist and the engineer have done an excellent job of furnishing proper gasoline for changing motor designs. While science should keep step with motor demands, the petroleum industry needs a hundred or a thousand additional uses for petroleum products.

Literature is filled with words of difficult pronunciation, each a designation of some product that can be taken from crude oil. Unfortunately comparatively few of these words have ever been sent to the printer to become the designations of merchandise. There is no urgent need for another thousand of these words but there is need for a score or a hundred saleable products, which can be taken from crude oil.

The mills of an ore mining district were for years hedged about by huge piles of rock. Then some chemist discovered that this rock could be converted into an insulation whose manufacture was more profitable than zinc or lead. Hidden in still bottoms are products which will answer existing needs.

Petroleum has qualities to kill the insect but the amateur back-yard rose grower seldom goes to his corner service station on discovering blighted leaves. That may represent ineffective selling, still the scientist should remember that man's outstanding enemy today is the tiny bug and that in petroleum he has a weapon to win the major battles of this war.

Frequently someone of limited vision pleads that the scientist be given a holiday for petroleum and refining practices left stationary for a spell. Any endeavor left stationary at that moment begins losing ground.

What the petroleum industry needs is its present scientific program geared to keep step with the automobile, the oil burner and the steam boiler. Beyond that it needs an addition to the laboratory where gasoline and other distillates never will be considered. This addition should delve more deeply into crude oil and see what it possesses in other products.

Too often the entire petroleum industry looks only on products in gallons and barrels. Somewhere in its make-up someone should consider containers of smaller size. In special products of higher price there is room for profit far beyond that which comes from orders in barrels and gallons.

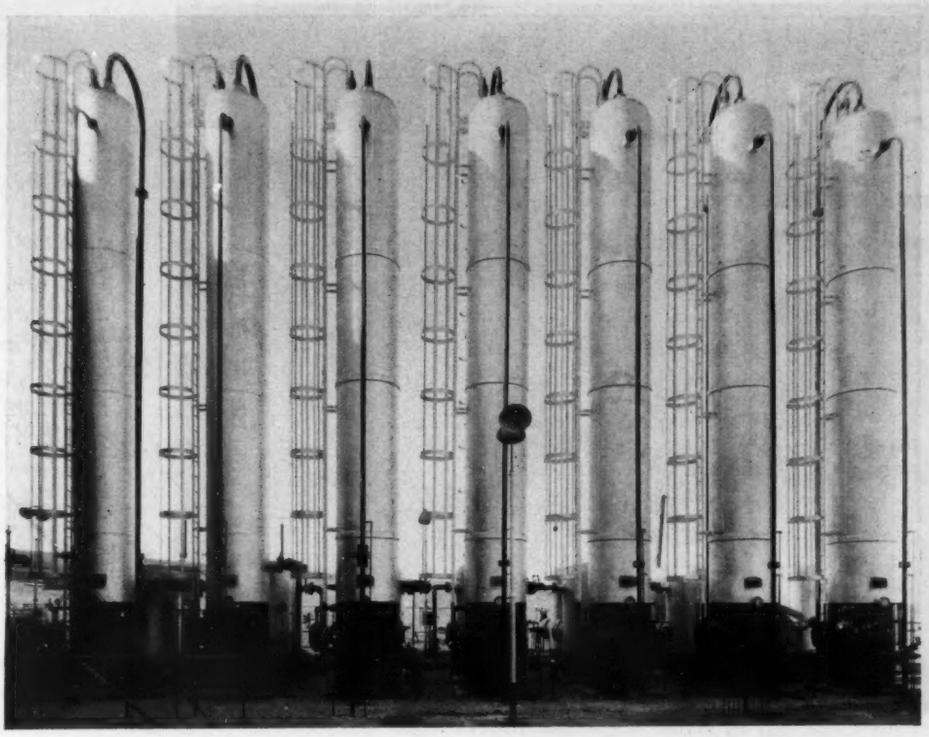
Perhaps the petroleum industry has been lulled by the fact that its present major markets came without research. The automobile market was handed over. Only then did research come along. Since then it has been concerned with keeping step with motor development.

If there is perfume in petroleum hydrocarbons no balance sheet will be bolstered thereby. But if some man or some laboratory can find a way to get petroleum into the cosmetic shops of the world there will be a major move in petroleum circles.

ACTIVITY on the part of a group within and associated intimately with the industry, probably is to result in some restriction being placed on the importation of crude and refined oils into the United States. This move has been fostered by growing imports from South America and a decrease in exports of both crude and refined oils from the United States. The increase in imports is much greater than the loss in exports, but the trend is marked—so much so that the end of economic significance of exports of oil from the United States appears imminent.

As is always the case in public discussions of such matters, it has been pointed out that some of the imported oil is brought in by foreign-owned companies, but the great bulk comes from foreign subsidiaries of American concerns. These same companies were invited to go forth and secure for the United States, as a measure of conservation and safety, deposits of petroleum in foreign parts, by the same government that is now moving to have the imports stopped. Possibly it was foresight on the part of the companies concerned that they have been building and planning to build refining plants near their foreign production, so that stopping imports into the United States will mean that the foreign plants will supply the foreign markets, and loss of exports from the United States will be accelerated when crude and gasoline which have been coming into this country are diverted to the world market.

In the meantime, other governments, notably Canada which has been and is a good customer, are encouraging refinery construction by tariffs on refined products. With users of American oil wishing to refine their own, and the crude being available at lower prices from South America and other sources of production, a tariff or an embargo on oil coming into the United States can only hasten the day when if American refiners are to participate in any but their home markets, it will be with oils refined in plants which they have or will build outside of the United States.



Battery of seven absorbers operating at 500 pounds pressure, at the new gasoline plant of Superior Oil Company, North Dome, Kettleman Hills field, California.

Kettleman Hills Plant Operates At High Pressure

By BRAD MILLS
Staff Representative

SUPERIOR Oil Company's absorption plant on the North Dome at Kettleman Hills was designed to meet exacting conditions in a most unusual field; built in record-breaking time and placed in operation on October 25, 1930, the plant represents an expenditure of more than $500,000.

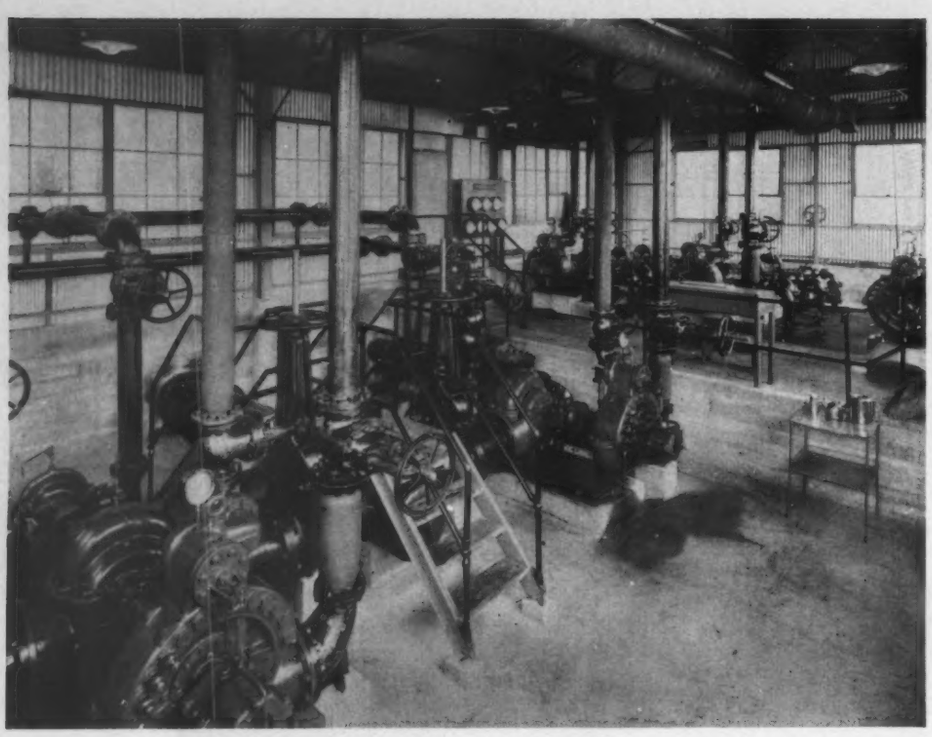
Various installations to be subjected to hard or unusual service were designed and arranged to obtain a more efficient extraction while incorporating an additional safety factor. Field conditions at Kettleman Hills are unlike those in any other California field, and the new plant plainly reflects the care exercised in meeting problems encountered in the operation of earlier plants on the North Dome.

The plant is a two-unit installation, with a capacity of 100,000,000 cubic feet of gas. At the present time it is handling only the gas from Superior Oil Company's Huffman 1, but the plant was primarily built to handle gas from at least two wells. Huffman 2 is drilling below 6000 feet, while Huffman 1, the original producer, was completed with an initial flow of 11,000 barrels and is still producing this amount of 40 gravity oil.

The first wells completed on the North Dome indicated that an absorption plant might be needed for each oil well. Gas production ran as high as 175,000,000 cubic feet in a single well. With the completion of Superior Oil Company's Huffman 1, a much better gas-oil ratio was obtained and it was evident that one plant might serve two or more wells.

The plant is one of six in operation on the North Dome, the field having become a center of natural gasoline manufacture within two years. The high well pressure offers many advantages, but at the same time presents many problems not encountered in the average low pressure area.

The plant, designed and erected by C. F. Braun and



Interior of pump house and control room. All pumps are turbine driven using gas drive instead of steam. Residue gas is reduced to 275 pounds pressure for driving the turbines.

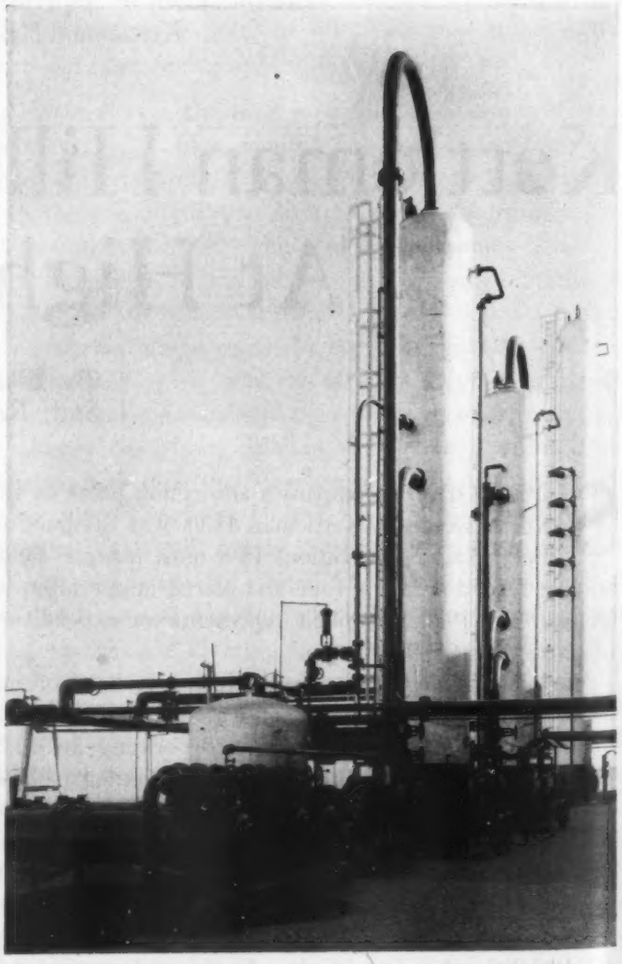
Company, consists of a dual absorption and distillation unit and a single stabilizer unit to serve the plant. Flexibility of design to meet operating conditions in the field and to remove the possibility of more than a partial shutdown was considered.

One of the distillation and absorption units is capable of treating 80,000,000 cubic feet of gas per day at a pressure of 500 pounds per square inch. The other is a combination unit to care for an additional 20,000,000 cubic feet of high pressure gas and from 6,000,000 to 8,000,000 cubic feet of low pressure gas and tank vapors. The oil circulation in the two units is approximately the same, about 425,000 gallons per 24 hours being circulated in each. In handling both high pressure gas and low pressure and tank vapors, the combination unit meets field conditions satisfactorily.

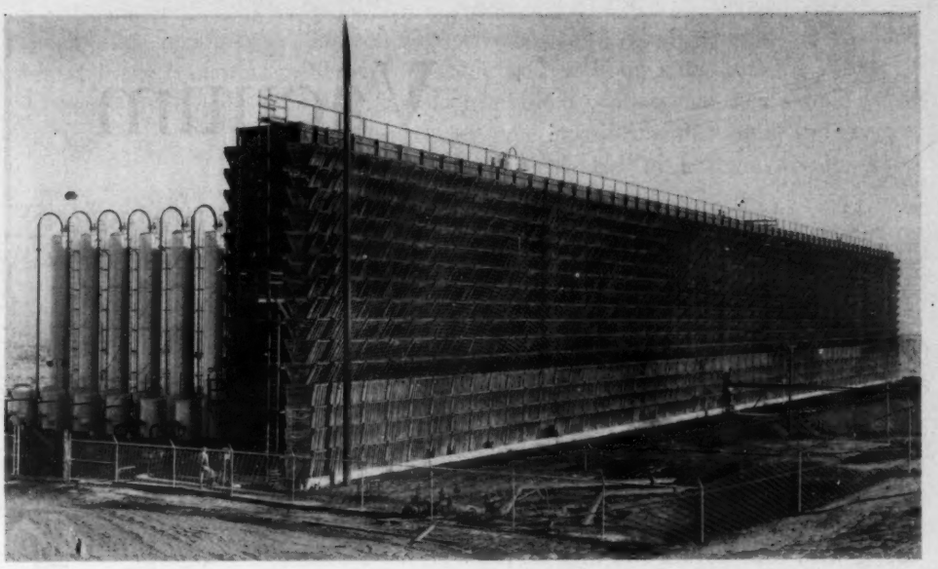
FEATURES OF DESIGN

The bubble columns are all of welded construction with cast iron bubble caps mounted on rolled steel trays electrically welded to the shell. For test purposes columns are fitted with thermo wells and sample connections at every tray. This arrangement speeds either plant routine or special testing during changes caused by the nature of gas treated and mechanical variations.

The heat exchangers and preheaters are of the shell and cylindrical type, with removable admiralty metal tube bundles and cast semi-steel bodies. The exchanger banks are fully fitted with by-pass valves, which together with the removable covers allows cleaning or repairs of individual exchangers without a shutdown of the entire unit. In fact, it is not necessary to break pipe connections for any alteration except a complete removal of the tube bundle. This is an improvement over early type exchangers and preheaters which were



Distillation units and the stabilizer unit which treats the raw gasoline after distillation.



Condensers, gas coolers, stabilizer reflux condensers, and oil and gasoline coolers, are all installed in the base of the cooling tower, which is 350 feet in length and 50 feet high. A tunnel through the base of the cooling tower provides for quick passage from pump house to gasoline storage tanks.

sometimes thrown out of commission through need of minor repairs.

The fracto-stills serving the distillation units are each equipped with external preheaters which receive the fat oil immediately after the first flash in the still and return it after heating. This reheating reduces the amount of agitation steam required. The heat thus supplied is, of course, recovered in the heat exchangers.

Condensers, gas coolers, stabilizer reflux condensers, and oil and gasoline coolers are straight tube open sections, all intalled in the base of the ventilator-separator type of atmospheric cooling tower. The cooling and condensing equipment consists of 42 open type sections.

The cooling tower is unusually ample, the owner having in view the periods of almost absolute calm that occur frequently during the hot months. Spray distributors are used over the coolers, as well as at the top of the tower. The tower is 350 feet long and 50 feet high.

For greater flexibility of operation and ease of cleaning, a series parallel arrangement of coolers is used. The piping is so arranged that any unit may be operated with a portion of the cooling bank by-passed.

GAS DRIVEN TURBINES

Pumping of oil, water and reflux is accomplished by De Laval centrifugal pumps connected in multiple to gas driven turbines. The turbines may also be steam driven if desired. Residue gas from the high pressure absorbers is reduced to about 275 pounds per square inch and heated by steam before feeding to the turbine. The reciprocating pumps for stabilizer charging and reflux, gasoline shipment and lean oil transfer are also gas driven, with steam as an alternative power. This dual arrangement may prove especially useful in case of emergency, or necessity for changing under less critical circumstances.

Except on water suction lines, all valves, fittings and tube turns are extra heavy. Connections at various points about the plant were installed to meet any conditions which may arise through extraordinary circumstances.

An unusual plant feature is a tunnel through the base of the cooling tower which provides quick passage from the pump house to the rundown tanks, which are installed on the opposite side of the tower from the plant proper.

By equipping the fracto-stills, which serve the distillation units, with external reheaters, a distinct saving in agitation steam is effected. These heaters take the fat oil from the still and return it heated with a minimum of energy.

Construction of the plant, which is normally rated at 100,000,000 cubic feet daily and with a stabilizer capacity of 150,000 gallons daily, was made in record breaking time.

Superior Oil Company supervised the installation of the boiler unit, which consists of nine, 175-horsepower National Supply Company boilers. They are capable of producing steam up to 416° F. through partial superheating. These boilers are a type suitable for drilling purposes also, the installation having been made with the possibility that certain requirements under the gas conservation law may make drilling more necessary than gasoline plant operation. This was merely a far-sighted move on the part of the company, however.

The recovery of natural gasoline has averaged about 2,000,000 gallons per month since the plant was placed in operation. The average gasoline extraction is now 1.71 gallons per 1000 cubic feet of gas treated.

Both the low pressure and high pressure gas are precooled before treating. About 15,000 gallons of gasoline per day are recovered in this cooling process. Gasoline condensed in this way is used for reflux in the stills.

The excess propane from the stabilizer reflux accumulator is piped up and blown off to the atmosphere above the cooling tower, since there is no market for it. The plant is now treating less than half of its rated capacity, but even at this low rate of operation has proven a profitable addition to the company's field facilities.

Vacuum

By GERRITT VAN DEN BERG
Designing Engineer, Gulf Refining Company, Port Arthur, Texas

IN the middle ages Papin constructed a pot in two halves, ground the joints, evacuated the pot and tried to pull the pot apart by trying four horses to each half. Papin called his vacuum a vacuum of eight horsepower. Had he tied his pot to a tree he would have found that he could have done the same thing with four horses and then he probably would have called it a vacuum of four horsepower.

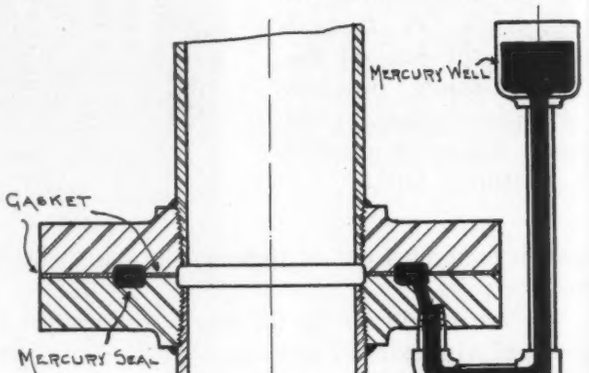
Later Toricelli's method of using a mercury column was developed and the vacuum or emptyness measured as a differential to the barometric pressure in inches mercury. A perfect vacuum therefore will measure 30 inches differential.

The measurement of vacuum as differential causes confusion. The vacuum technician of today no longer uses this differential but uses absolute pressures. For rough calculations of vacuum inches mercury may be used, but for finer determinations and measurements the millimeter mercury and thousands of a millimeter mercury are employed.

In the United States this new unit: 1/1000 millimeter mercury is called micron. In Europe it is termed "mu." Tabulating this one has: Atmospheric pressure: 30 inches equals 736 mm mercury absolute pressure. Absolute pressure: one inch equals 25 mm mercury. Absolute pressure: 1/1000 mm mercury equals—micron (the U. S. A. unit). Absolute pressure: 1/1000 mm mercury equals—mu (European unit).

Evacuating has become a special science, similar to extremely low freezing. In extreme low temperature it has been determined that electrical resistance disappears. In extreme low pressures only undirectional flow of electricity is possible through certain gases. In this new field 1/1000 or 10^{-3} mm mercury is still a rough vacuum. Pressures as low as 10^{-13} mm mercury are reached. Those pressures can not be measured but must be calculated from the carefully gathered pumped out air. Furthermore in these low pressures the amount of left over molecules becomes of interest to the physicist. He wishes to chase them all out. How difficult this is, is indicated by the total molecules that usually crowd into a cubic centimeter,—about three by 10^{19}.

Returning to the more practical low pressures it will be recalled that Edison established a high and permanent vacuum for incandescent lamps 50 years ago. Since then these permanent high vacuums have become essential in our existence. Electric bulbs for lighting, radio and X-raying, vacuum bottles and jugs are constant reminders of the application of vacuum. Pressures of one to 10 micron can be maintained for years. This development is attributed to development in the electrical field.



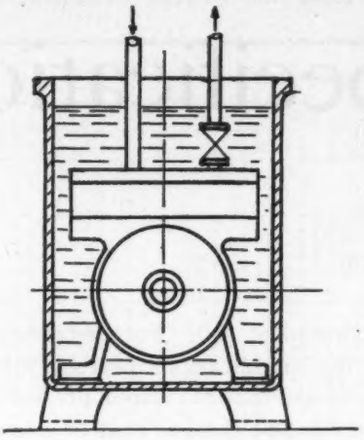
SKETCH No. 1
Typical high vacuum flange with mercury seal.

In other fields vacuum technique has made much little comparative progress. In many power plants, stationary as well as ship power plants, a vacuum of 25 to 26 inches is regarded as satisfactory. In alcohol, fruit juice, and molasses stills, as well as in gasoline and lubricating oil still, vacuum of 26 to 28 inches are maintained.

In nearly all cases low pressure is produced by condensation, and in fact condensation leads all other methods as a producer of vacuum. To demonstrate one assumes that a steel vessel of 1675 cubic feet volume is filled with steam at atmospheric pressure and at 212° F. By pouring enough cold water over the walls of the container the steam will condense to one cubic foot of water. If it is possible to remove all of this water a perfect vacuum will result. In common practice water is evaporated, condensed, pumped away, and a perfect vacuum would exist continuously if air did not leak in. Air leakage determines the 26 and 28 inch, and 99.9 per cent vacuums. Air ejectors, air pumps, and the like are employed for the re-establishment of the vacuum through the removal of air which leaks into the system.

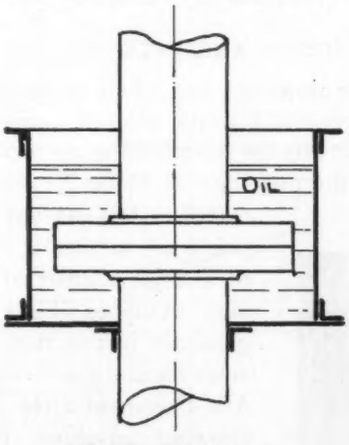
The capacity of the necessary air pump therefor mostly is determined by a good "guess." A well designed and fabricated system will be erected and oper-

ated with an air pump of small capacity, but a poorly designed and poorly maintained system will not function satisfactorily without an air pump of large capacity.



SKETCH No. 2
Oil-submerged vacuum pump

Tightness, or the lack thereof, of vacuum vessels, pipe connections and the like, is the greatest trouble to the vacuum technician. In attempting to produce a tight vacuum system the designing engineer will eliminate as many flange connections as possible. As intruding air escapes into the interior of the system it becomes increasingly difficult to trace small leaks in flanges and similar connections. Although welding is resorted to as much as possible the use of flanges can not always be avoided, and therefore the flanges must be designed with maximum security against leakage.



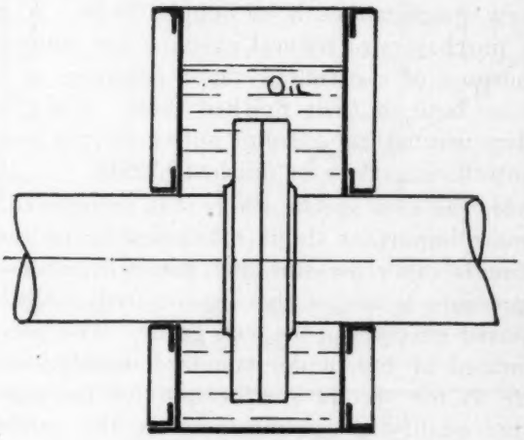
SKETCH No. 3
Vacuum flange connection with suggested oil seal

SEALS

Electrical firms employ a mercury seal as is shown in sketch Number 1. Another seal, used by air pumps in submerging the complete pump with valves and stop-valves in heavy oil, is shown in Sketch Number 2. This type of seal might well be employed at certain points in oil refining, but so far as is known little or no practical use is made of this feature.

Bolted and riveted connections should be avoided wherever possible and welding substituted. Where it is necessary to use bolted connections they should be of the high pressure type, possibly with tongue and groove, and sealed—as is illustrated in sketches Numbers 3 and 4.

The importance of air leaks can be demonstrated as follows: suppose a cubic foot of atmospheric pressure air leaks into a 26-inch vacuum, or a four-inch absolute pressure. According to Mariotte's law this air will expand to a volume of— $\frac{30}{4} \times 1 = 7.5$ cubic feet. Then assume that the same volume of one cubic foot of air leaks into a 99.9 per cent vacuum. From a pressure of 736 mm it expands to $\frac{736}{1000}$ mm mercury, and according to the same law, pv = constant, assumes a volume of $\frac{736}{\frac{736}{1000}} \times 1 = 1000$ cubic feet.



SKETCH No. 4
Vacuum flange connection with suggested oil seal.

In a high vacuum this leakage would be detrimental, but in a rough vacuum a normal size air pump could easily take care of it.

Another factor to take care of in vacuum systems is that of the non-condensible gases, or those gases which will not condense under the conditions existing in the system. Propane, for example, will not condense unless temperature and pressure in a condenser are in accordance with the characteristics of this gas—it condenses under atmospheric pressure at minus 45°C., which means that in ordinary water cooled equipment it will not condense. The problem can be met more easily than that of air leakage because usually the amount of non-condensible gases can be determined by experiment and analysis.

Use of the New Natural Gasoline Specifications

A Digest of a Paper

By S. S. SMITH
Shell Petroleum Corporation

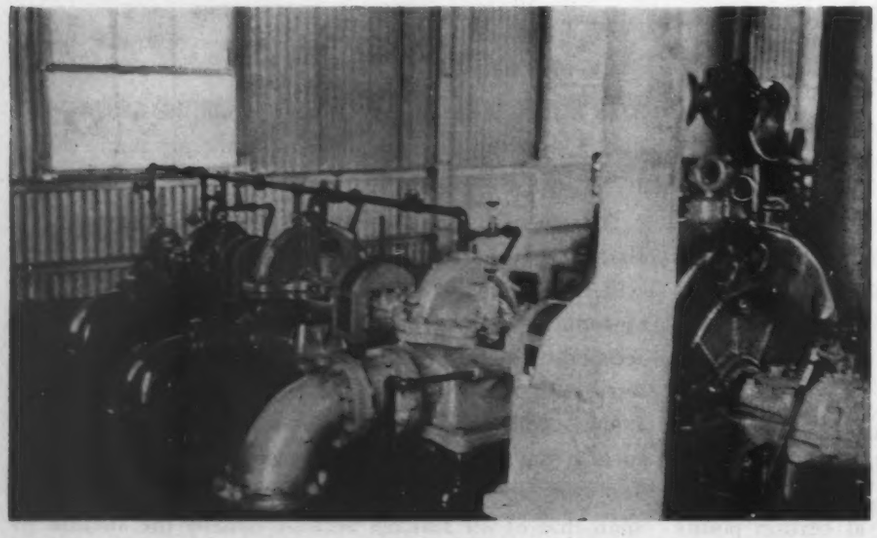
THE new natural gasoline specifications adopted by the Natural Gasoline Association of America during the first part of December, 1930, were published in the Refiner and Natural Gasoline Manufacturer, issue of January, 1931, page 126. The data released by the association for this article gave rough comparisons between the old "AA", "BB", "A", "B" and "C" with the new grades and showed that, roughly, the purchaser of gasoline who had previously been buying "AA" could reasonably expect to get approximately the same gasoline under the new specifications if he bought 26-70. A great many purchasers of natural gasoline use natural for the purpose of controlling vapor pressure, or volatility, or both of their finished fuels. Many other blenders use natural gasoline solely for the purpose of controlling gravity of finished blends.

Under the new specifications it is recognized that the most important single characteristic of natural gasoline is vapor pressure and, therefore, excess vapor pressure is one of the unpermitted qualities of purchased gasoline of a given grade. The per cent evaporated at 140, under standard distillation procedure, is the second specification for the gasoline and the qualifying specifications is the minimum amount evaporated at 140. For instance, under the 26-70 grade, the qualifications necessary in the gasoline purchased are that the vapor pressure shall not exceed 26 pounds and the per cent evaporated at 140 shall not be less than 70 per cent. If, however, we attempt to tie these definite limits of vapor pressure and volatility into definite limits of gravity, we find the extreme divergence possible in particular grades somewhat wider than the old grades. Therefore, to make comparison between the old and the new specifications it is necessary to assume that the specifications of products delivered will in most cases fall at or near the specification limits.

Similarly, it is reasonable to expect that purchasers of gasoline under the new grading system will receive gasoline which crowds the upper limit of vapor pressure within the particular grade and shows tendency to approach the lower limit of volatility at 140 within the particular grade.

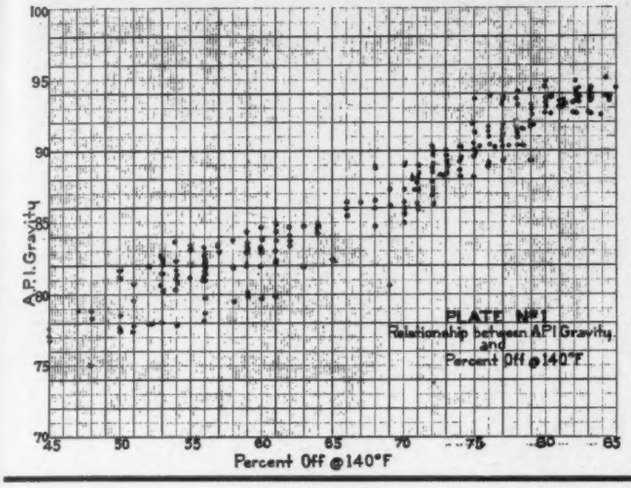
CURVES ARE INTERESTING

If these assumptions are taken as sound, then the attached curves of gravity plotted against per cent evaporated at 140 are illuminating as to what can be expected in the purchase of 55 or 70 per cent evaporated at 140 gasoline. These data points are arrived at by inspection of a large number of Mid-Continent gasolines, Plate 1 showing gasolines just as they are shipped from natural gasoline plants in the Mid-Continent field and Plate 2 showing gasolines prepared by fractionation from normal Mid-Continent gasolines to fall in all the vapor pressure grades. It is interesting to note from Plate 1 that the gasolines which fall at 70 per cent off at 140, exactly range in gravity from 85 to 89 or, roughly, within the limitations of the old "AA" grade. When such gasolines are controlled to 26 pound vapor pressure by fractionation they will fall close to 70 per cent



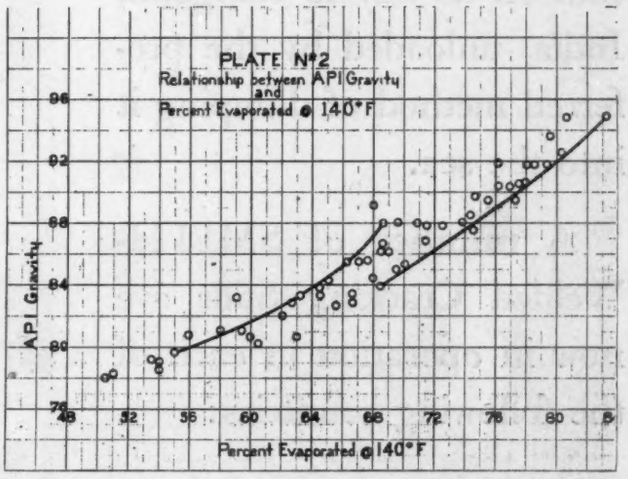
Modern installation of Single Shaft Operating Pumps in series with Turbine Drive in a Natural Gasoline Plant.

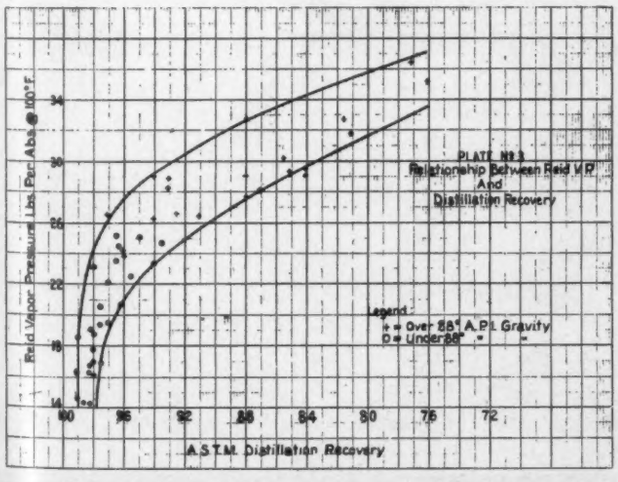
at 140 and the gravity range will be limited to perhaps two degrees up or down from 86 gravity. Plate 3 illustrates this point. It shows the A. S. T. M. distillation recovery as ordinates against the Reid Vapor pressures at 100 as abscissae on the same gasoline shown in Plate 2. The legend of these individual points shows crosses denoting the distillation points and Reid vapor pressures of gasolines having in excess of the 88 degrees A. P. I. gravity while the points denoted as circles show gasolines of lower than 88 gravity. It will be noted that only one gasoline below 26 pound vapor pressure has a gravity in excess of 88 degrees and this particular gasoline happens to have a gravity of 88.2. This, in general, shows the relationship which is attempted to prove, viz, that 26 pound gasoline of 70 per cent at 140 will not have gravity in excess of 88 degrees A. P. I. It will immediately be recognized that all of the foregoing data ties up the new grade, 26-70, to the old grade "AA" and more or less ignores the importance of the other grades.



INDUSTRY WAS HANDICAPPED

There is a general feeling in the natural gasoline industry that it has been somewhat handicapped in its sales efforts by the fact that effectively the industry had only one recognized grade for sale, that of "AA". To those purchasers of natural gasoline who consider natural gasoline as something to be used sparingly and in as little volume as possible, this gives sufficient data to enable the purchase of 26-70 replaceably with their old grade "AA". It is the hope of the natural gasoline industry however, that many refiners who have recognized the necessity for controlled vapor pressure will immediately see the new grades as an opportunity to purchase naturals of specific quality for specific uses and thereby increase the field of usefulness of natural gasoline as well as broaden its demand to the makers of special aviation fuels, high volatile motor fuels and so-called high test gasolines.




Reid Vapor Pressure Lbs. Per Abs. @ 100°F
PLATE N°3
Relationship Between Reid V.P. And Distillation Recovery
Legend:
+ = Over 88° A.P.I. Gravity
O = Under 88° " "
A.S.T.M. Distillation Recovery

Data are available in the literature which make it possible for any refiner or user of natural gasoline to accurately prophesy distillation points of the finished blend of any percentage of natural with any percentage of refinery blending stocks. Market prices such as obtained at present are conducive to the use of high gallonages of natural gasoline which high gallonages, however, have been impossible with the old specifications, due to the fact that vapor pressures of naturals were not accurately controlled. The new specifications are an alternate specification with the old specifications through the year 1931 and it will be advisable for users of natural to buy gasoline under the new specification so that when they do ultimately, as of January 1, 1932, become the sole specification, there will be no difficulty in handling of purchase and sales contracts due to failure of buyer or seller to become familiar with these new specifications.

117 SMITHWELDED CRAC

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SMITHWelded Cracking Still on its way to Rangoon, India, unloaded by the preferred method of dumping it into the sea.

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Curacao	Japan
Italy	Mexico
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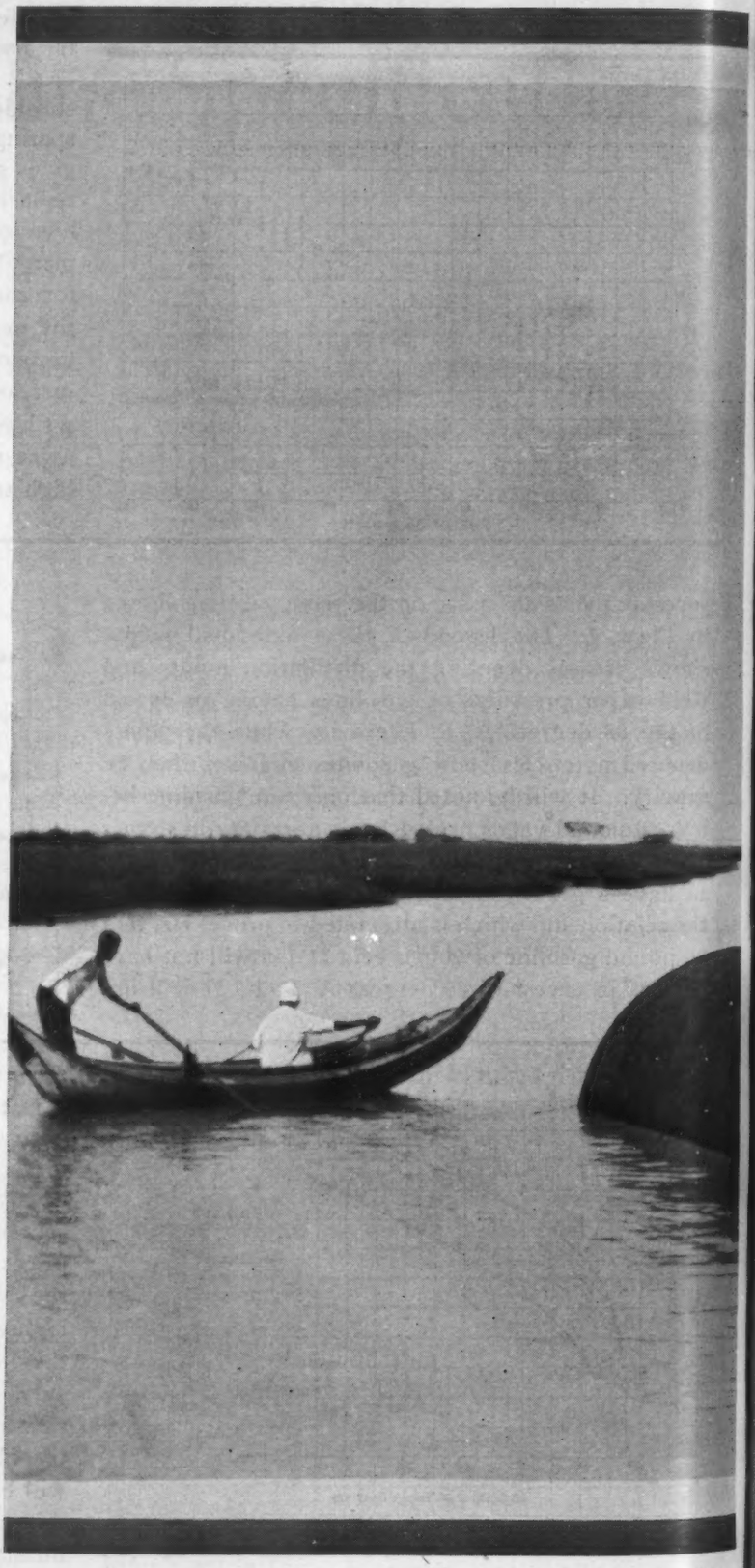

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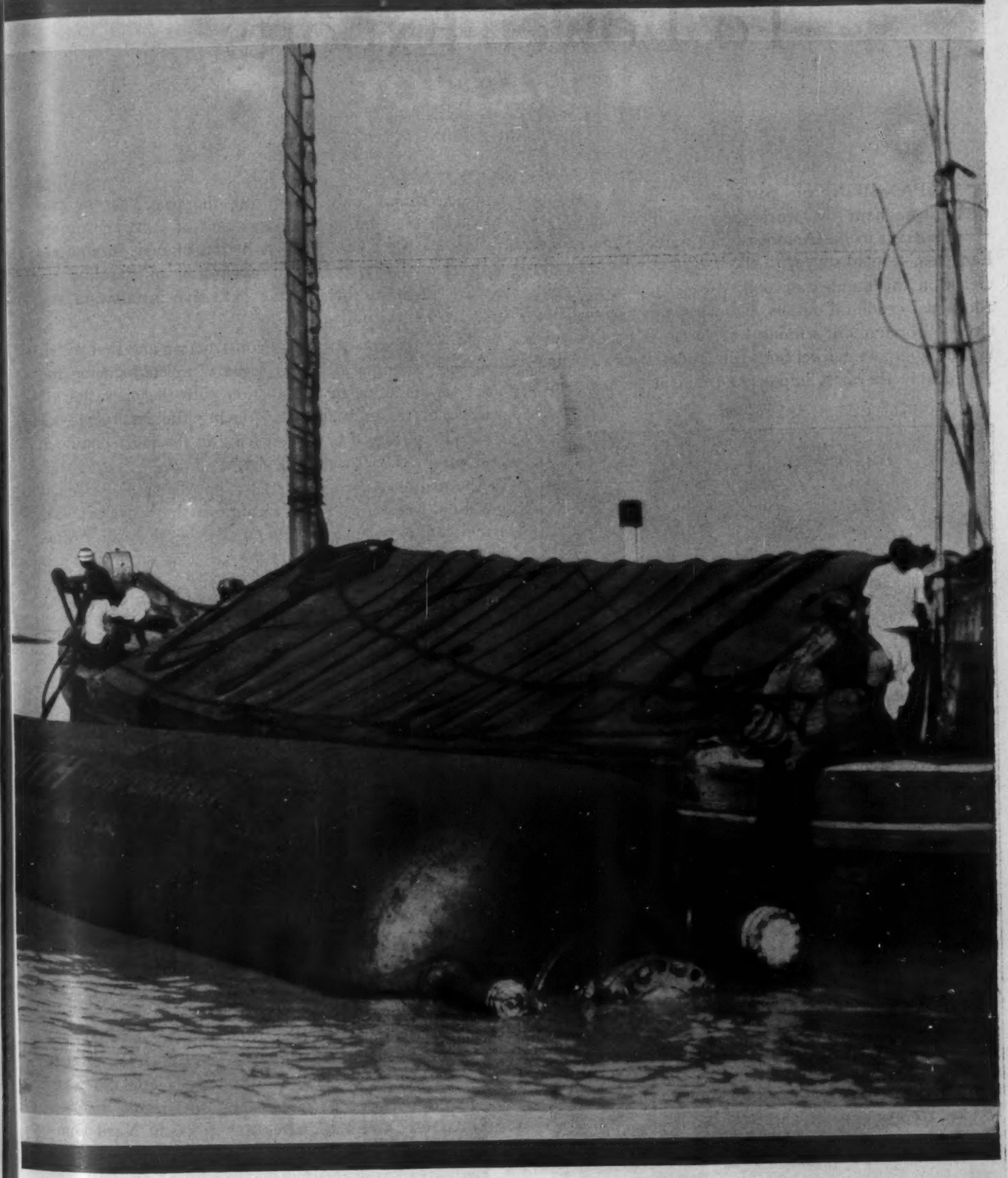
KING STILLS OVERSEAS



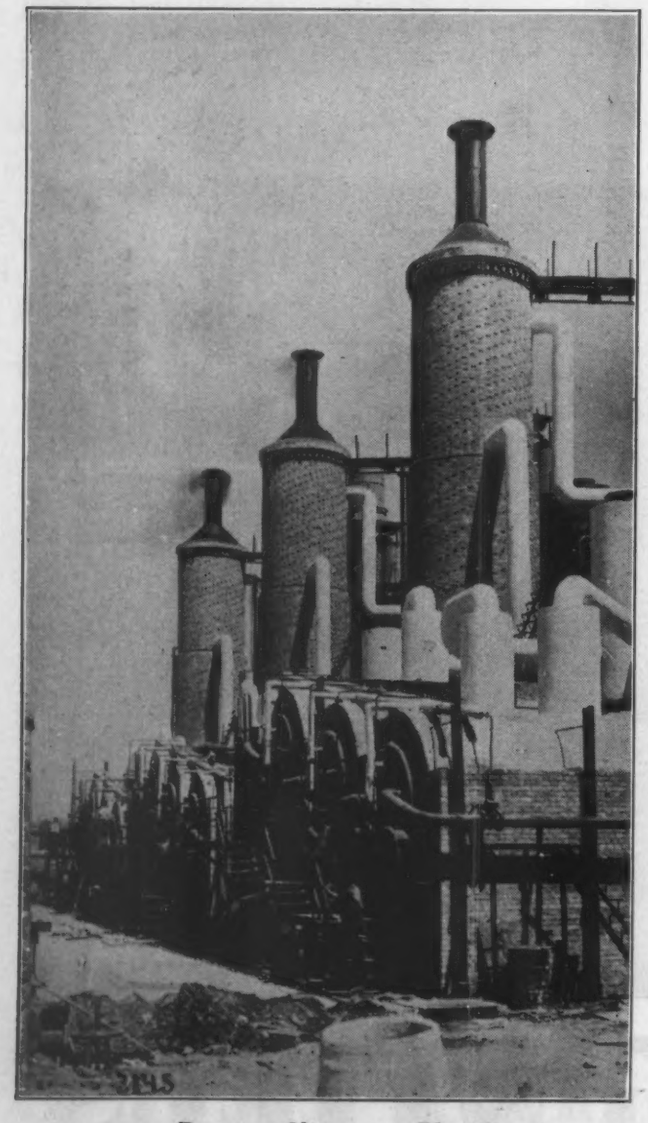
CRACKING STILLS

Foreign Refining Expansion To Lower Exports

By GEORGE REID
Associate Editor

EXPANSION of petroleum refining facilities throughout the world becomes increasingly important to the American oil producer and refiner. Each semi-annual survey of the industry indicates an increase in the number of domestic refineries, affording additional crude oil outlets, but with increases in capacity of foreign oil refining enterprise indicative of a lessening export market both for crude oil and gasoline.

Probably the most important trend in the economics of the refining industry during the past year or two has been the continued enlargement of existing foreign refineries, the continued installation of new foreign refineries and the consistent expansion of gasoline recovery facilities through the extensive installation and use of the cracking process.



Russian Skimming Plant

The completion of present construction and that which has been announced and is to be completed during the next few months, in conjunction with the operation of additional capacity installed during the last year—all of which occurred or is occurring in the most populous and progressive of the foreign countries—must result in the manufacture and distribution of much additional gasoline, kerosene and lubricants, with the result that American exports must eventually be reduced. This will eventually affect the importation of crude into the United States through diversion of oil now being imported to foreign countries for processing.

New construction of foreign plants at present and over the last six months has been for the greater part confined to South America, Mexico, Canada and France.

A resume of activities made in August, 1930, showed five major foreign refineries building or completed during the first half of the year. Since that time work has been started on 10 more refineries, and two more have been proposed. Nor does this include the rather ambitious program of the Russians who, in a semi-official report, are credited with determination to construct more capacity in the next two years than they have in the past two years. The following foreign refineries have been built, are building, or have been announced since August, 1930:

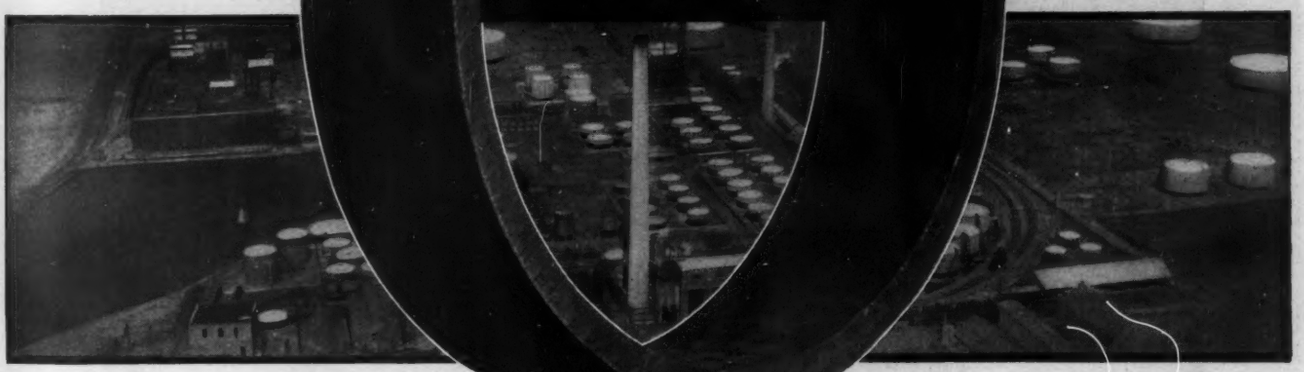
Diadem Petroleum Corporation (Dutch - Shell), Buenos Aires, Argentina, 3500 barrels; General Fuel Company, Buenos Aires, Argentina, 1000 barrels; Cia Petrolia y Refinéria Eureka, Tampico, Mexico, 300 barrels; Mexican Eagle Oil Company (Dutch-Shell), Mexico City, Mexico, 5000 barrels; Societie des Raffinerie de Petroles de la Gironde, Bordeaux, France, 7500 barrels; and Raffinerie de Petrole du Nord Dunkirk, France, 5000 barrels.

The foregoing companies have built, or are building, 22,300 barrels of additional refining capacity in the countries mentioned. In addition to this list the following work has been done:

Dunubia Mineraleolindustrie, A. G. at Vosendorf,

AFTER 6 MONTHS IN ACID SLUDGE TONCAN IS

JUST LIKE NEW



THE section of Toncan Iron Pipe illustrated here was taken from an acid-sludge line which had been in service over 6 months at the Coffeyville Refinery of Sinclair Refining Co. Note that despite this severe corrosive service, the pipe is entirely free from pitting or corrosion—and there has been no perceptible loss in weight.

Further evidence of Toncan's permanence, and the ability of Toncan Copper Molybdenum Iron Pipe to far outlast other pipe under severe corrosive conditions.

Nor is this an isolated example of the service given by this remarkable alloy. It is only one of many similar instances where Toncan Iron Pipe has proven its ability to outlast other ferrous pipe only slightly cheaper in first cost.

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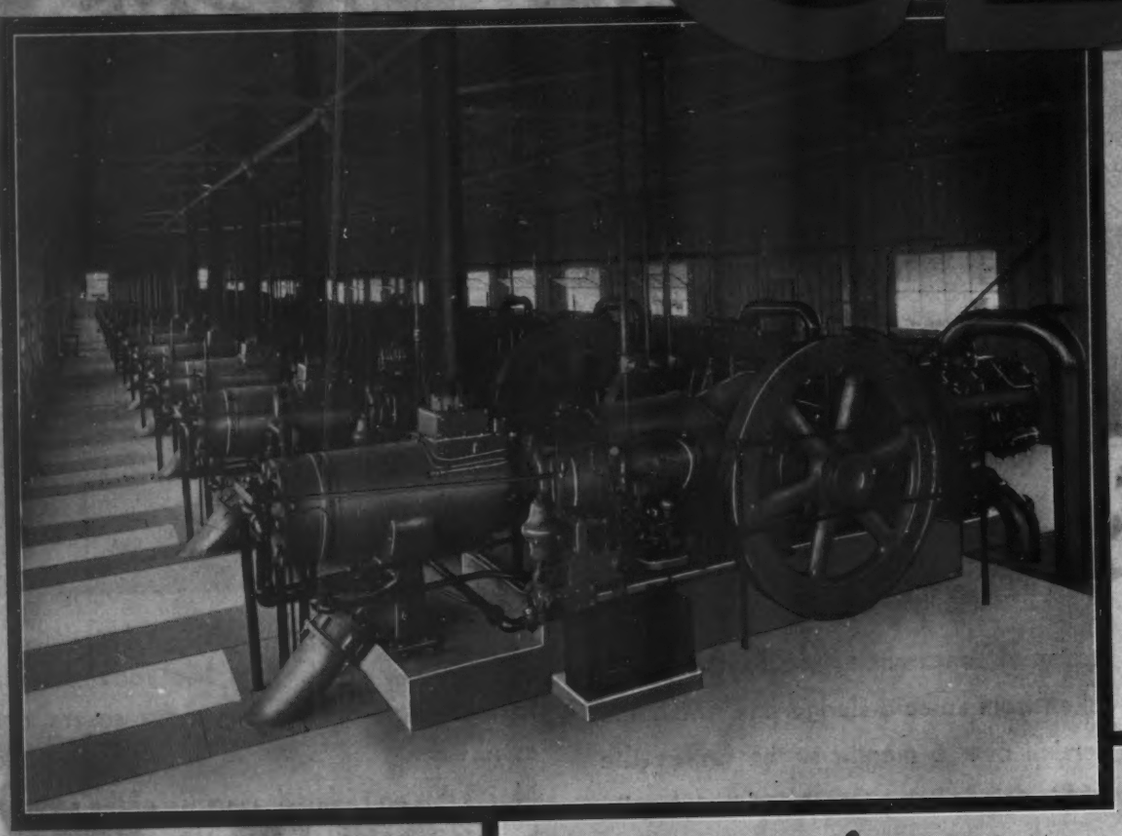
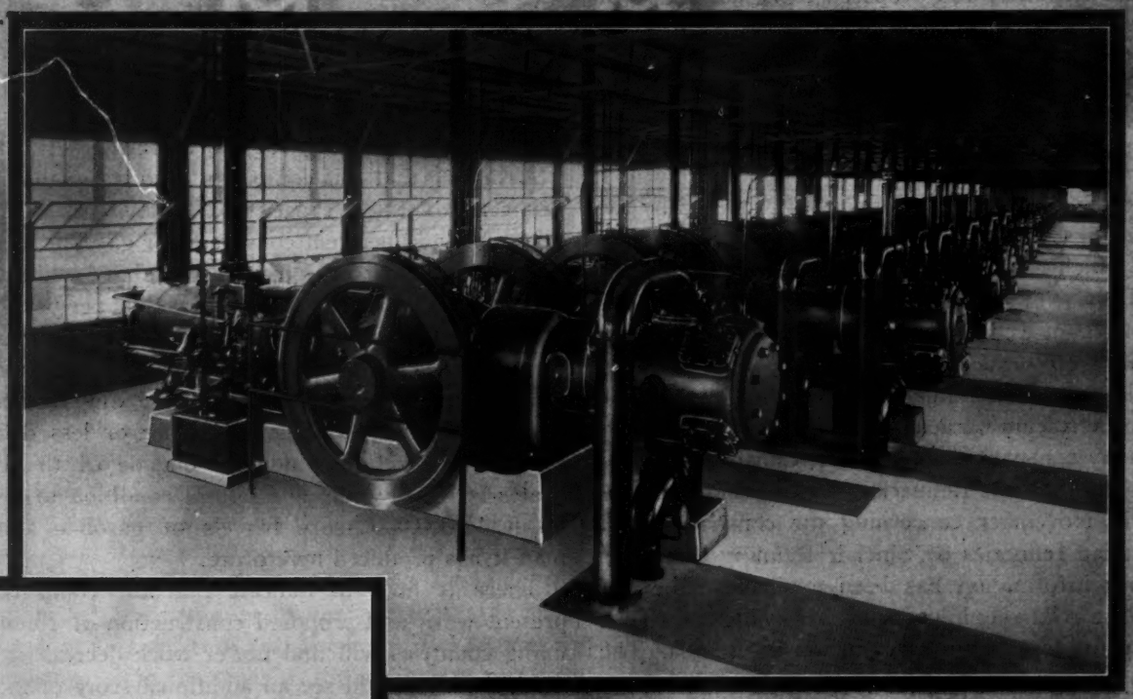
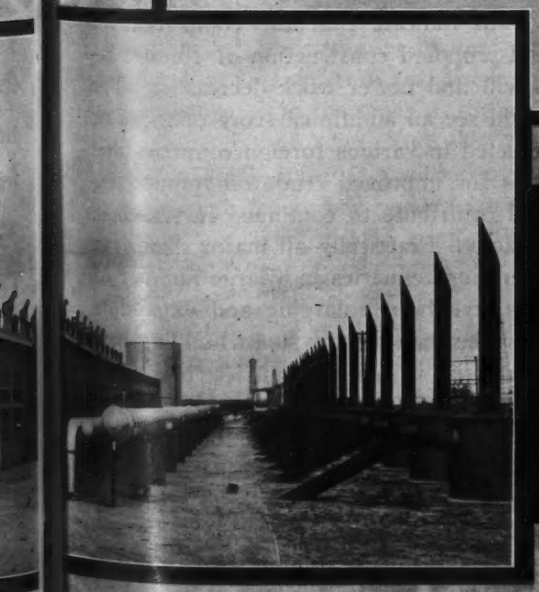


GAS CONSERVATION-

ARKS





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Austria, has erected a 365-barrel plant; West India Oil Company has entered the refining business in Trinidad with a 1000-barrel plant; and one refinery in Yugoslavia has doubled capacity by the addition of 1335 barrels capacity.

Various refineries in England have been reconditioned and enlarged through the installation of modern facilities, to the end that present capacity in this country is near 41,000,000 barrels annually, or an increase of 20,000 barrels daily capacity over reports of last year. Several refining installations in France, Germany, Italy, Roumania, Persia and Poland have been improved and capacities increased, but no definite figures are available with which actual barrels capacity increase can be pictured. The foregoing estimates, however, give a total of 22,700 barrels additional capacity in the countries mentioned or a grand total of 45,000 barrels new capacity in foreign countries either now building or recently erected.

Spain, through her Spanish monopoly has completed a 5000-barrel capacity refinery at Santa Cruz de Tenerife, Canary Islands, and proposed the construction of a 5000 to 10,000 barrel plant at Barcelona. Plans for the construction of other refineries on the north, east, and southern coasts of Spain are reported to have been deferred.

ANOTHER SOUTH AMERICAN REFINERY

Another South American refinery is proposed by the Peruvian Oil Corporation (controlled by American interests), which company plans a 10,000-barrel plant at Borza, Peru. Three more plants are proposed for Canadian provinces, which include a 2500-barrel refinery at Winnepeg by Independent Refiners, Ltd., a 1000-barrel plant at Edmondton to be erected by Atlantic Keystone Petroleum Company, and a plant of 3000 barrels capacity somewhere in Western Canada, proposed by McCool Frontenac Refineries. Since the reports appearing in November concerning the construction of five Canadian refineries by Sinclair Refining Company, no further information has been available. The imposition of a relatively high import duty on gasoline has given impetus to refinery construction in Canada. The total capacity of the above reported proposed foreign refineries is 16,500 barrels. This added to the previous total of 45,000 barrels brings the total new and proposed capacity figure to 61,500 barrels per day.

The five refineries previously mentioned as building or recently completed at the middle of last year, with a combined capacity of 17,000 barrels give a grand total of new foreign capacity added within the last year, and to be completed within the next few months, of 78,000 barrels per day. This equipment, operating at 80 per cent of rated capacity, 300 days per year, and securing 25 per cent gasoline, will produce approximately 5,000,000 barrels of gasoline for distribution and consumption in the foreign countries mentioned, and this amount of gasoline, in all likelihood, will effect a similar volumetric decrease in imports to the countries.

From the standpoint of available gasoline gallonage in foreign countries the extensive application and the widespread adaptation of the cracking process by foreign refiners constitutes a greater threat to the American trade balance, in so far as gasoline exportation is concerned, than does the erection of new and improved crude oil refining facilities. With increases in the cracking departments of refinery, it does not necessarily follow that any increase in crude oil consumption may be evidenced, for the cracking unit consumed only certain heavier distillates and the residues of the crude already processed in existing plants.

CRACKING EXPANSION

During the period from July, 1929, to July, 1930, a total of 57 cracking units were constructed and placed in operation in Japan, the West Indies, South America, Continental Europe, the East Indies, Egypt, Mexico, Italy, Russia, Canada and England. The total capacity of these units was 97,000 barrels per day.

At the present in Japan, Persia, France, Italy, Sweden, Argentina, India and Mexico there are 18 cracking units being erected with a total charging capacity of 38,300 barrels per day. With the units completed recently and with the building now in course of completion the 75 cracking units will represent additional capacity totaling 135,300 barrels.

Assuming that this equipment is to be operated at 90 per cent of rated capacity, 275 days per year, and secure only 30 per cent conversion or gasoline recovery, then the cracking equipment listed above will yield an additional 10,000,000 barrels of gasoline per year, above the production of the same refineries in the countries mentioned, as of one year ago. Thus through the utilization of new refineries and new cracking installations recently erected, building, and more or less definitely planned, the refining industry outside of the United States is rapidly getting itself in condition to produce about 15,000,000 more barrels of gasoline annually, than it has produced heretofore.

There is little to indicate that the completion of present work and proposed construction of foreign refining countries will find newer work decreasing. The coming year should see an additional score or more of cracking units erected in various foreign countries and large expenditures for improved crude oil refining facilities which will contribute to continued increases in total refining capacity. Practically all major American oil companies operating refineries in a large number of foreign countries have been enlarging and expanding their plants during the past year or so, or building new plants. Tariffs imposed in many countries, high tank ship rates, possibility of import tariffs in this country, and other contributing factors all point to the advisability of refinery construction and operation in populous and most progressive foreign countries. Further increases capacity in foreign countries through the next two years will contribute to the diminution of exports from the United States.

The Compression Of Hydrocarbon Gases

By I. N. BEALL, *Chemical Engineer*

AN understanding of the fundamental principles upon which pertinent engineering calculations are based is always of assistance in the solutions of those practical problems which arise during the course of plant design, construction, and operation.

The compression of natural gas falls particularly well within the confines of the above statement. Thermodynamics finds its major industrial application in the formulation of equations relating work and heat through the medium of an expanding or contracting gas. Gases provide the only practical means whereby heat may be converted into mechanical energy. The translation of heat into energy and the reverse process of transforming energy into heat through the resiliency of gases and vapors have resulted in the establishment of a system of conversion factors whereby heat units may be expressed in energy equivalents.

Thus for example the so-called universal gas constant R is an energy symbol expressed in heat units in the equation $M\ (C_p - C_v) = R$, where M = molecular weight, C_p = the specific heat of the gas at constant pressure, C_v = the specific heat of constant volume, and R = 1.986. In the mathematical expression $_{pv} = nRT$ of Boyles and Charles Laws for the behavior of the volume of the perfect gas with changes of temperature and pressure, R becomes an energy term. On the basis of the volume of one molpound of gas at 32° F and 14.7 pounds per square inch = 358.7 cubic feet and converting pounds per square inch to pounds per square foot $14.7 \times 144 = 2116.8$

$$R = \frac{358.7 \times 2116.8}{M(459.6+32} = \frac{1544}{M} \text{ foot—pounds.}$$

Since R = 1.986 in heat units, 1 B.T.U. $= \frac{1544}{M} \div \frac{1.986}{M} = 777.54$ foot-pounds. The horsepower unit as

$$1 \text{ H.P.} = \frac{33000}{777.54} = 42.442 \text{ B.T.U.}$$

It is evident that the foregoing calculations are based upon the assumption of the perfect gas and the applicability of Boyle, Charles, and Dalton's concepts. The properties of actual gases are known to vary widely from the assumed properties of the perfect gas, in consequence of which correction factors have to be applied to the perfect gas equations in order to have them conform to actual conditions as determined by experiment and established through practice. The broader generalizations are, however, none the less valuable, as they constitute the foundation upon which the more accurate specific calculations are based.

ISOTHERMAL AND ADIABATIC GAS SYSTEMS

When a gaseous system undergoes a change of volume without a change of temperature, the process of change is designated as isothermal. Under conditions of expansion, heat has to be added to maintain the temperature constant; under compression, heat must be removed. Gases heat on compression unless heat is removed; they cool on expansion unless heat is added.

Where heat is neither added nor removed from an isolated gas system undergoing change of volume the process of change is said to be adiabatic. Neither perfect isothermal or adiabatic processes are actually realized in practice, although both are at times very closely approximated. The greater the rapidity of compression, the more nearly are adiabatic conditions approached. Isothermal conditions are approximated by slow compression and use of large cooling surface. Ordinarily, the horsepower requirements are said to be maximum for adiabatic compression, and minimum for isothermal compression.

Conditions might exist where the temperature intensity of enclosing walls might increase the horsepower over that required for adiabatic compression, or cooling lower the horsepower requirements below that of isothermal compression. In such cases additional temperature corrections would apply to the calculations. An example of the first case would be that of a very cold gas entering a heated cylinder and undergoing compression. A hot gas of small $\frac{C_p}{C_v}$

If we bent all our efforts to make gasoline to suit the automobile engine instead of people's whims and notions, everybody would be better off

The engine is always right —people's whims and notions are often wrong

That's the way it is with color in gasoline It is people who do all the kicking You never hear the engine complain about it

Color certainly makes no difference to the engine, yet

look what it costs refiners to meet this color fad

Volatility and knock rating —that's all the engine cares about Dubbs cracked gasoline has it

Dubbs cracking means profits to the refiner, because he can make this good gasoline from cheapest charging stock at lowest cost

Universal Oil Products Co
Chicago, Illinois

Dubbs Cracking Process
Owner and Licensor

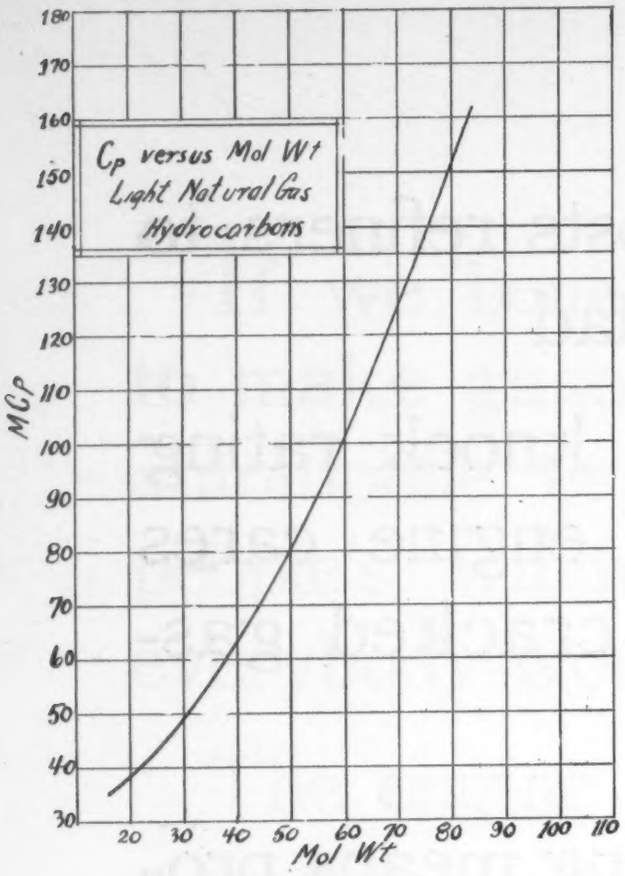


Chart No. 1

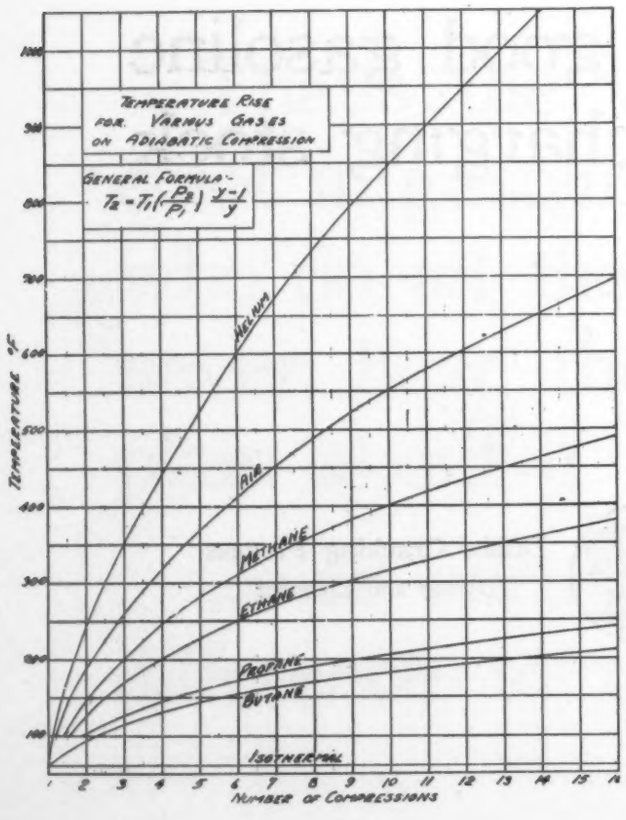


Chart No. 2

ratio entering a cold cylinder and undergoing compression would be an example of the second case.

SPECIFIC HEATS AT CONSTANT PRESSURE AND AT CONSTANT VOLUME

Specific heat is the ratio obtained by dividing the quantity of heat, Q, required to raise the unit rate (one pound) through one degree Fahrenheit, by the quantity of heat required to raise a unit weight (one pound) of water from 62°F. to 63°F. It has been suggested that a more correct designation than specific heat would be "Coefficient of thermal capacity."

For gases, there are two specific heats, that measured at constant pressure and that at constant volume; the designations are C_p and C_v respectively. Both are heat quantity rather than heat intensity ratios. C_p is always greater than C_v for any given gas as additional energy is always required for expansion at constant pressure. The general relation between the two specific heats is frequently expressed by the equation $MC_p - MC_v = R$ where M is molecular weight and R is the gas constant 1.986. However like most general laws this is an approximation based upon the behavior of perfect gases, and as such serves for a guide and basis for comparison. For the inert gases such as argon, neon, krypton, helium, etc., it is practically quantitative at least for the lower ranges of temperature and pressures, for other gases among which belong the hydrocarbons, the use of such a generalization leads to serious errors in calculations. C_p values for any hydrocarbon vary with both temperature and pressure as also do the values of C_v. Furthermore all indications are that MC_p and MC_v values increase with the ascension of the series, see chart Number 1. The ratio $\frac{C_p}{C_v} = \gamma$ upon which the thermodynamic formulae for adiabatic compression depend, decreases in value with increasing molecular weight within the series C_nH_{2n+2}. The same may be said of other homologous series. The scant experimental evidence is that the values of gamma decrease with increase of temperature and increase with increasing pressure above certain limits.

The present trend in experimental and industrial synthesis is towards higher pressures and temperatures. Natural gas is especially susceptible to high pressure reactions and by reasons of its abundance, purity and low cost, an attractive raw material. In view of the present enormous amount invested in compression machinery and the future possibilities it is surprising that there is so little accurate information available on the fundamental subject of specific heat. The general formula for the specific heat of any gas at constant pressure may be expressed by the following formula $C_p = A + Bt + Ct^2$

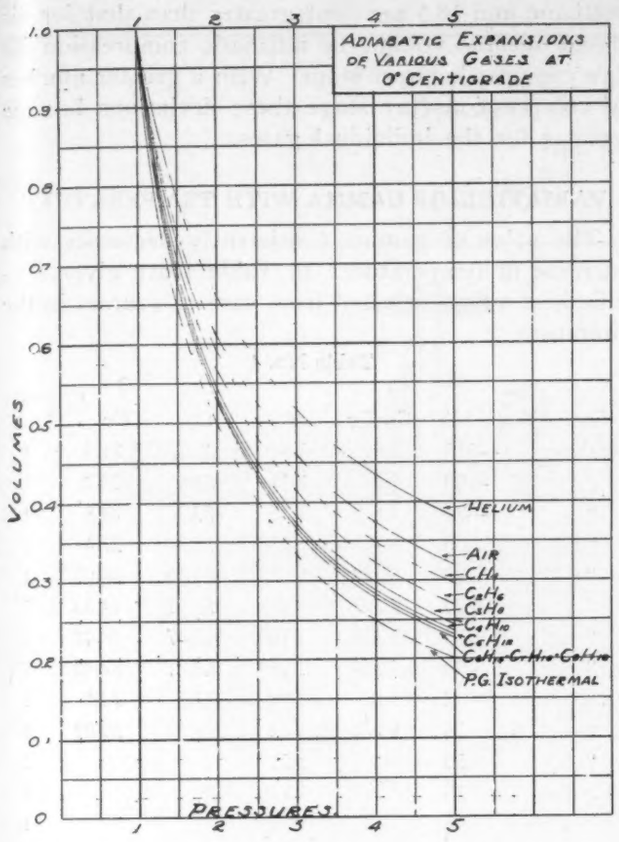


Chart No. 3

$+Dt^3$, and the mean specific heat over a temperature range t_1 to t_2 by

$$C_p = \int_{t_1}^{t_2} \frac{A+Bt+Ct^2+Dt^3}{t_2-t_1}\,\delta t$$ which by integration

$$C_p = A+B/2\,(t_2+t_1)+\left[\frac{C}{3}(t_2+t_1)^2-t_2\,t_1\right]+$$

$$D/4\,(t_2+t_1)\left[(t_2+t_1)^2-2t_2\,t_1\right].$$

Taking t, as 0° abs. the equation becomes

$$Cp_0-t_2 = A+B/2t_2+C/3t^2{}_2+D/4\,t^3{}_2.$$

In the above equations A, B, C and D are constants which have to be evaluated for each gas. For temperatures ordinarily encountered in compression C and D become so small as to be negligible. The numerical values of the constants are determined by substituting experimentally determined values of C_p at various temperatures; the constants are obtained from the simultaneous equations thus formed. The quantity $\delta = C_p - C_v$ is computed from the thermodynamic relation

$$\delta = T\left(\frac{\delta p}{\delta T}\right)_v \left(\frac{\delta v}{\delta T}\right)_p$$

The values of

$$\frac{\delta p}{dT};\ \frac{\delta v}{\delta T};\ \frac{\delta p}{dv}$$

have to be obtained either by direct measurement, thru an individual equation of state known to give correct values of pv and T for the gas in question, or else deduced from a general equation of state such as that given by Leduc.

The ratio $\frac{C_p}{C_v} = y$ depends in some unknown manner upon the velocity of sound through the gas, the La Place equation is Velocity

$$= \sqrt{E/d} = 1/d \sqrt{-y\frac{\delta p}{\delta v}}$$

Observed velocity is reduced to velocity as used in the equation through the Kirchoff equation

$$\text{Vel. obs.} = V\left(1-\frac{k}{2r\sqrt{_1 T N}}\right)$$

Inasmuch as the y values are the one sought as the exponential factor for adiabatic compression, the methods for its direct determination are of great value. The y values generally used in engineering calculations for compression are taken from the equation $y = \frac{\log P_1 - \log P_2}{\log V_2 - \log V_1}$. This exponent is usually written s.

PRACTICAL APPLICATION OF GAMMA FUNCTIONS

The adiabatic relationships between pressure, volume and temperature are as follows:

$$\frac{V_2}{V_1}=\left(\frac{P_1}{P_2}\right)^{\frac{1}{y}};\ \frac{P_2}{P_1}=\left(\frac{V_1}{V_2}\right)^{y};\ \frac{T_2}{T_1}=\left(\frac{V_1}{V_2}\right)^{y-1};\ \frac{V_2}{V_1}=$$

$$\left(\frac{T_1}{T_2}\right)^{\frac{1}{y-1}};\ \frac{P_2}{P_1}=\left(\frac{T_2}{T_1}\right)^{1+\frac{1}{y-1}};\ \frac{T_2}{T_1}=\left(\frac{V_1}{V_2}\right)^{\frac{y-1}{y}};\ -$$

where P_1 = initial absolute pressure pounds per square inch.

P_2 = final absolute pressure pounds per square inch.

V_1 = initial volume in cubic feet.

V_2 = final volume in cubic feet.

T_1 = initial absolute temperature °F.

T_2 = final absolute temperature °F.

On chart Number 2 the temperature rise for various gases are plotted from values obtained through the equation $T_2 = T_1 \frac{(P_2)}{(P_1)}\ \frac{y-1}{y}$

The values of gamma used in the equation are those taken from chart Number 2. It is obvious upon examination of the chart, why compressors are said to run cooler on the richer gases. The higher hydrocarbons have gamma values which approach the unity of isothermal compression. The formula

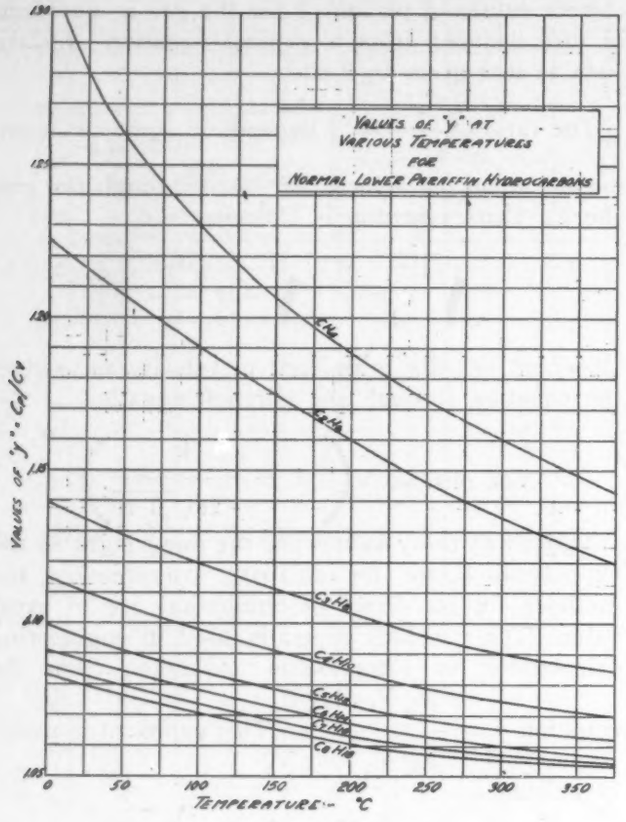


Chart No. 4

for the theoretical horse power required for adiabatic compression is

$$H.P. = \frac{144\ N\ P\ Vy}{33000\ (y-1)}\left[\left(\frac{P_2}{P}\right)^{\frac{y-1}{Ny}} - 1\right]$$

where N = equals number of stages of compression.
P = suction pressure in pounds per square inch absolute.
P_2 = final or discharge pressure in pounds per square inch absolute.
V = actual volume in cubic feet per minute at suction pressure.
$y = C_p/C_v$ = exponent of the compression curve.

The formula for isothermal compression is given by $H.P. = \frac{144\ PV\ (\text{hyp. log}\ \frac{P_2}{P_1})}{33000}$. In the formula for the theoretical horsepower required for adiabatic compression it will be found that —y decreases in value as the horsepower requirements go down.

As the number of stages of compression increase the horsepower requirements decrease. Chart Number 3 shows the adiabatic expansion of various gases a O°C = 32° F based on unit values of volume and pressure. It is obvious upon examination of the chart how the efficiency of compression varies for the different gases. For P = 5, Volume of ethane = 0.32. This indicates the efficiency of compression for ethane = 9.3 per cent greater than that for methane and 18.5 per cent greater than that for air based on final volume by adiabatic compression for five compressions per stage. With a greater number of compressions per stage these deviations become greater for the individual gases.

VARIATION OF GAMMA WITH TEMPERATURE

The value of gamma consistently decreases with increase of temperature. In Table 1 are given specific heat values selected from various sources in the literature.

Table No. 1

Gas	Temp.°C	Cp-Cv	y	Cp	Cv	Pressure Atm.
Methane	—115	8.8	1.41	30.2	21.4	1
"	—80	8.6	1.34	33.8	25.2	1
"	—74	8.6	1.35	33.4	24.8	1
"	0	8.4	1.307	35.8	27.4	1
"	100	8.353	1.232	44.36	40.05	1
"	200	8.337	1.188	52.61	44.36	1
"	300	8.328	1.160	60.47	48.42	1
"	400	8.324	1.139	68.01	52.40	1
Ethane	—82	9.6	1.28	43.7	34.1	1
"	15	8.734	1.22	48.55	39.82	1
"	50		1.21			1
Propane	16		1.13			0.5
Isobutane	15		1.11			1

It is evident from Table 1 that calculations based upon one y value of a gas would not apply for all temperatures. Inasmuch as the actual volume of the gas at intake temperature is used in the calculations of horsepower for adiabatic compression, increased volumetric cylinder capacity should be allowed for hot gases in accordance with the decrease in the exponential gamma values. Heat transfer conditions within the cylinder are also better as the temperature differences between the gas and walk increases. Hot gas may leave the cylinder at a lower temperature than which it enters. The writer has noted such conditions when hot vapors from an absorption oil stripping column are sent to the compressors for compression before condensation.

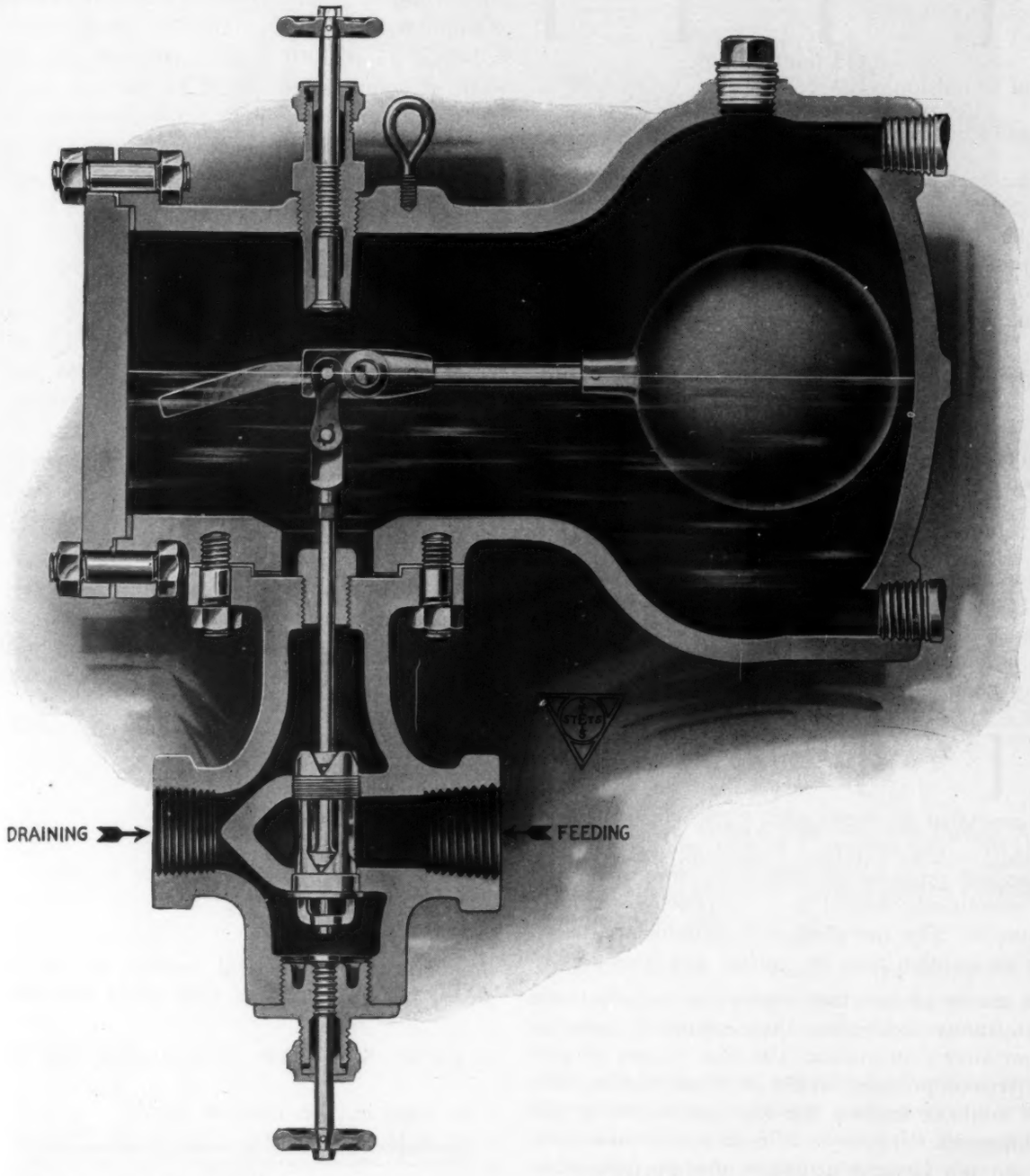
VARIATION IN WORK OF COMPRESSION FOR HYDROCARBONS

The total work required for compression for no clearance conditions, is that of compression and expulsion less that of admission. Pressures are expressed in pounds per square foot absolute which is 144 × pounds per square inch absolute; work in foot-pounds. For example 1000 cubic feet of methane at 25 pounds per square inch absolute suction pressure = 25 × 144 = 3600 pounds per square foot. 1000 cubic feet × $\frac{14.7}{25}$ = 588 cubic feet at 3600 pounds per square foot. 588 × 3600 = 2,116,800 foot-pounds = work of admission. This gas is compressed to

STETS COMPANY

141 Milk Street

BOSTON, MASSACHUSETTS



STETS LIQUID LEVEL REGULATOR

For feeding liquids to boilers, stills or pressure vessels where the liquid level is to be maintained and the rate of input is to equal the rate of output.

For draining condensed liquids from stills, heater receivers or tanks where liquid level is to be maintained and rate of output is to equal rate of input.

Constructed of materials suitable for the service.

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100 pounds per square inch absolute; the work of compression is $\frac{3600 \times 588}{y-1}\left[\frac{(14{,}400)^{\frac{y-1}{1}}}{3600} - 1\right]$ which for y = 1.30 becomes

$$\frac{3600 \times 588}{1.30-1}\left[\frac{.30}{(4)\ 1.30} - 1\right] = 7{,}056{,}000\left[\frac{0.231}{(4)} - 1\right]$$

= 2,660,112 foot pounds.

Work of expulsion $(100 \times 144) \times$ volume after compression $= Vc = \frac{588}{(4)^{1/y}} = 588 \div (4)^{0.77} =$ 202 cubic feet. $100 \times 144 \times 202 = 2{,}908{,}800$ foot pounds. Work expended = (2,660,112 + 2,908,800) —2,116,800 = 3,452,112 foot pounds.

For propane y = 1.13 at 25° C. The amount of work for admission would be the same as that for methane assuming the gas laws. The volume after compression $= \frac{Vb}{(4)^{1/1.13}}$ for where V_b = 588 cubic feet P_b = 25 pounds per square inch absolute and P_c = 100 pounds per square inch absolute as before, becomes

V_c = volume after compression $= \frac{588}{(4)^{0.885}} = 172$ cubic feet.

$172 \times 14400 = 2{,}476{,}800$ foot pounds = work of expulsion.

Work of compression $= \frac{P_b V_b}{y-1}\left[\left(\frac{P_c}{P_b}\right)^{\frac{y-1}{y}} - 1\right] =$

$$\frac{2{,}116{,}800}{0.13}\left[(4)^{0.115} - 1\right] = 2{,}984{,}600 \text{ foot pounds.}$$

Work expended = (2,984,600+2,476,800 — 2,116,800 = 3,344,600. The difference in foot-pounds between methane and propane for 1000 cubic feet under the above conditions 3,452,112 — 3,344,600 = 107,512 foot-pounds. The foregoing calculations are based on the assumption that the perfect gas laws hold.

As a matter of fact the volumes of both methane and propane would be less than calculated both before and after compression also the volume of propane after compression would be much smaller than that of methane making the work of expulsion less than indicated. Vapors at or near equilibrium pressures can not be said to follow the gas laws even approximately. Molal volumes may be as low as 25 per cent of that as calculated on the assumption of a perfect gas.

According to the perfect gas laws, if the pressure is doubled, the volume is halved or, if the absolute temperature is doubled, the volume is increased 100 per cent. Where a gas or vapor compresses at a faster rate than the reciprocal of the pressure, more work is required in going from P_1 to P_2 than for a perfect gas, but less work from V_1 to V_2. Suppose for example 1000 cubic feet of gas at 60° F. and 15 pounds is compressed isothermally to 75 pounds per square inch absolute. According to the gas laws the compressed volume would be $15/75 \times 1000 = 200$ cubic feet. If, on actual measurement, it is found that the compressed volume is only 150 feet, then there will be only three-fourths the work of expulsion as compared to 200 cubic feet. The work of admission is $144 \times 15 \times 1000 = 2{,}160{,}000$ foot-pounds. The work of compression would be the area under the PV curve between 1000 and 150 cubic feet and between 15 and 75 pounds per square inch. The amount of work, $W = \int PdV$ will depend upon the form of the pressure-volume curve.

ISOTHERMAL COMPRESSION

The isothermal curves vary for the individual gases, and also for each set temperature. It is a matter of regret that such fundamental data as this is not generally available for the hydrocarbon gases and vapors. General equations of state must be used in the absence of more exact experimental data. The writer will take up the subject of isothermal compression more fully in another article dealing specifically with hydrocarbons.

The exponent for the volumetric change with pressure change which was from 75 to 15 pounds in the example given; with a volume change of from 150 to 1000 cubic feet can be expressed by the formula $V_1 = V_2\left(\frac{P_2}{P_1}\right)^{1.1786}$ where the value 1.1786 is obtained from the equation

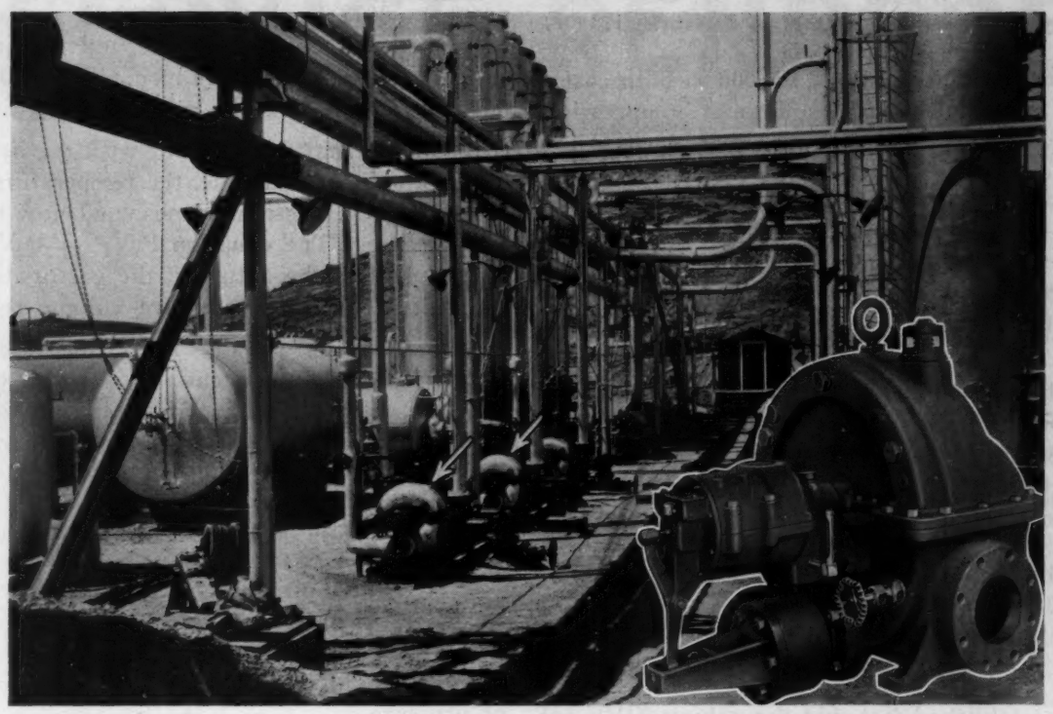
$$1/s = \frac{\log\left(\frac{P_2}{P_1}\right)}{\log\left(\frac{V_1}{V_2}\right)} = \frac{\log\ (5)}{\log\ (6^2/_3} = 1.1786$$

Substituting numerical values in the equation $V_1 = 150\ \frac{(75)^{1.1786}}{15} = 1000$ cubic feet. Since 1/S = 1.1786, S = 0.848. Substituting the value of S = 0.848 in the relation $P_1 V_1^S = P_2 V_2^S = K$ or $15 \times (1000)^{.848} = 75 \times 150^{.848} = 5325$. The equation for $W = \int \frac{KdV}{V^s}$ then becomes, $5325 \int \frac{dV}{V^s}$ or $5325 \int \frac{V_2}{V_1} V^{-s}\, dV = \frac{K}{1\text{-}S}\left[V_2^{1-s} - V_1^{1-s}\right] =$

$$\frac{5325}{0.152}\left[(150)^{0.152} - (1000)^{0.152}\right] = -25119$$

which by pounds per square foot — 25119 × 144 =

TERRY



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3,617,136 foot-pounds = work done on compression. The work of isothermal compression where S=1, is $W = P_2 V_2 \log_e \frac{P_2}{P_1} = P_1 V_1 \log_e \frac{V_1}{V_2} = 144 \times 15 \times 1000 \times \log_e S = 2{,}160{,}000 \times 1.61 = 3{,}377{,}600$ foot-lbs.

The work of admission = 2,160,000 in both cases. The work of expulsion for isothermal compression is 200 cubic feet × 75 pounds per square inch × 144 square inches per square foot = 5,760,000 foot-lbs. where the volume is 150 cubic feet at 75 pounds as in the first example for S = 0.848, the work of expulsion = 150 × 75 × 144 = 4,320,000 foot-lbs. The difference in work for the two examples is 1,200,464 foot-pounds greater for isothermal.

Thus it may be stated that where a gas is more compressible than the perfect gas, the work of admission for unit volume remains the same, the work of compression is greater than for perfect gas isothermal, the work of expulsion is less and the net-overall work for admission, compression and expulsion is less. On the basis of 100 cubic feet per minute, the difference in horsepower 1,200,464 ÷ 33000 = 36.44 H.P.

THE P. V. VALUES

It is an established fact that the values of PV are not constant for the gases, but a variable with temperature. The Van der Waal's equation $(p + \frac{a}{v^2})(v - b) = \frac{\text{constant}}{273} \times T$, attempts to account for this variation through the insertion of specific gas constants a = cohesion pressure and b = four times the absolute volume of the hypothetical molecules. The use of the a and b constants gives very much more correct values for PV than Boyles Law PV = P_2V_2 = constant for constant temperature, although the values thus obtained for the hydrocarbon gases and some others are far from rigidly accurate. The Van der Waal's equation is cumbersome and difficult of solution. Van der Waal's equation however brings out one fact clearly and that is that PV values pass through a definite minimum value on increase of pressure, and that this minimum is more pronounced the lower the temperature.

At the critical temperature on increasing pressure a point is reached where liquefaction begins, volume decreases rapidly for small changes of pressure, or at the absolute critical temperature and critical pressure volume is said to change without change of pressure. The point of critical temperature and pressure is in equilibrium, as the temperature is lowered below the critical temperature, successive equilibrium pressures are established. Recognition of these facts is of vital importance to the theory of vapor compression in total or partially condensing compression systems. The critical temperatures of the natural gas hydrocarbons are high with the exception of methane. The values for critical temperature are methane = —140°F., ethane = 95° F., propane=207° F., butane=307° F., pentane = 387° F. and the corresponding respective critical pressures in pounds per square inch, CH_4 = 736, C_2H_6 = 665, C_3H_8 = 660, C_4H_{10} = 522, C_5H_{12} = 482.

It is to be remembered that with the hydrocarbon gases other than methane, the temperature ordinarily used in compression are near or below the critical temperatures. The equation $P_1V_1^s = P_2V_2^s = K$ is independent of the nature of the gas or its temperature,—it is strictly a pressure volume relationship.

A method has already been illustrated for the evaluation of the exponential s. By this equation if the P_1V_1 value is known for a gas before compression and the P_2V_2 value after compression every intermediate value of V for changes of P can be found by use of the exponential s where

$$S = \log \frac{\text{(final pressure)}}{\text{initial pressure}} \div \log \frac{\text{(initial volume)}}{\text{final volume}}.$$

In general it may be stated that the higher the specific gravity of a natural gas or natural gas vapor, the more rapidly will the volume change on increase of pressure.

For methane an average value at ordinary temperatures is given as 0.228 per cent per atmosphere, ethane 0.90 per cent, propane 1.9 per cent. (Reference T.P. 158 U. S. Bureau of Mines by Burrell & Robertson). For high pressures the variations are considerable, even for a gas as light as methane. Propane at seven atmospheres has a volume 88 per cent of that as indicated by Boyles Law. The Van der Waal's constants for methane a = 0.00357, b = 0.00162, ethane, a = 0.0160, b = 0.0028, propane a = 0.01727, b = 0.00377. For solution $(P + \frac{a}{v^2})(V-b) = \frac{\text{constant}}{273} T$ is used in the form $p = \frac{(\text{constant} \cdot T)}{273\,(v-b)} - \frac{a}{v^2}$ the constant is formed $(1 + a)\ (1 - b)$ and arbitrary numerical values substituted in the equation. Otherwise the answer depends upon the solution of the cubic equation with respect to v, through roots being obtainable. The use of such equations is only justified where exact experimental data are lacking. Strictly speaking, it is not a working formula such as $P_1V_1^s = V_2V^s$.

Wet gases cannot be said to conform to the calculations used for evaluating the work required for the compression of fixed gases, such as air and dry natural gas. Each case of wet gas in the absence of an exact general equation of state must be sub-

(*Continued on page* 120)

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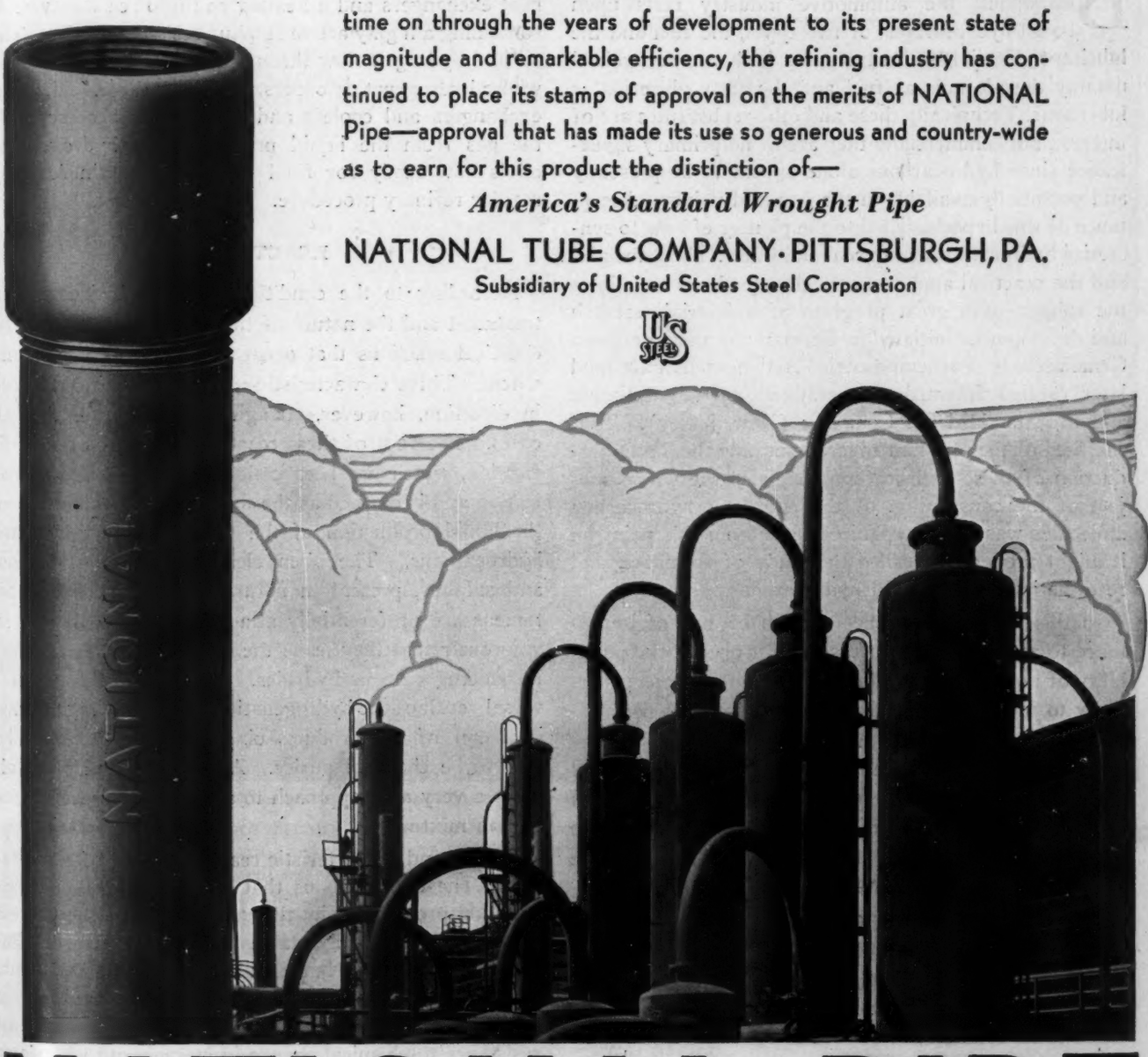


NATIONAL PIPE

WELDED OR SEAMLESS

Lubricants and Motor Fuels By Hydrogenation

By R. T. HASLAM and W. C. BAUER
*Standard Oil Development Company**

BOTH from an engineering and from an economic standpoint the automotive industry rests upon liquid hydrocarbons of two types, the fuel and the lubricant. Possible substitutes for both are recognized notably the alcohols as fuel and the fatty glycerids as lubricants. Technically these and other substitutes are of interest, but commercially they are of no primary significance since hydrocarbons alone appear to be presently and potentially available in the required volume. Acceptance of this hypothesis led to the pioneer efforts to synthesize hydrocarbons from coal and water. The principles and the practical application of this synthesis have been the subject of a great program of industrial research and development initiated in Germany by the Interessen Gemeinschaft Farbenindustrie Actiengesellschaft and later carried forward co-operatively by the initiators and the Standard Oil Company (New Jersey). That the field of the program covered not only the direct production of these hydrocarbons but also the whole subject of the constitution of the petroleum-hydrocarbon molecules was soon recognized, and from this point on it might properly be called the study of formation and reformation of the liquid hydrocarbons.

In this broader light the research became of importance to automotive engineers since it opened the possibility of not only the production of hydrocarbons generically to increase the available supply but also controlling or altering the constitution and properties of the synthetic products as well as hydrocarbons of natural origin to obtain that type of molecular structure which best lends itself to the requirements of the automotive industry. This paper deals with the latter aspect of the development.

The result of this program has been the perfection to the point of initial commercial operation of a process known generically as the hydrogenation process. Although the process has many variants and other uses, those to be considered here are the production of gasoline and lubricants with particular reference to the properties of the products. The process, as at present applied to these uses, consists briefly in pumping the charging stock, together with hydrogen compressed to between 3000 and 4000 pounds per square inch, through heat exchangers and a heating coil into reaction vessels containing a highly active sulphur-resistant catalyst. The oil and hydrogen flow through these reaction chambers where hydrogenation occurs, then back through the heat exchangers and coolers and into vessels that separate the gas from the liquid product. The hydrogenated oil is now ready for final distillation or finishing by regular refinery procedure.

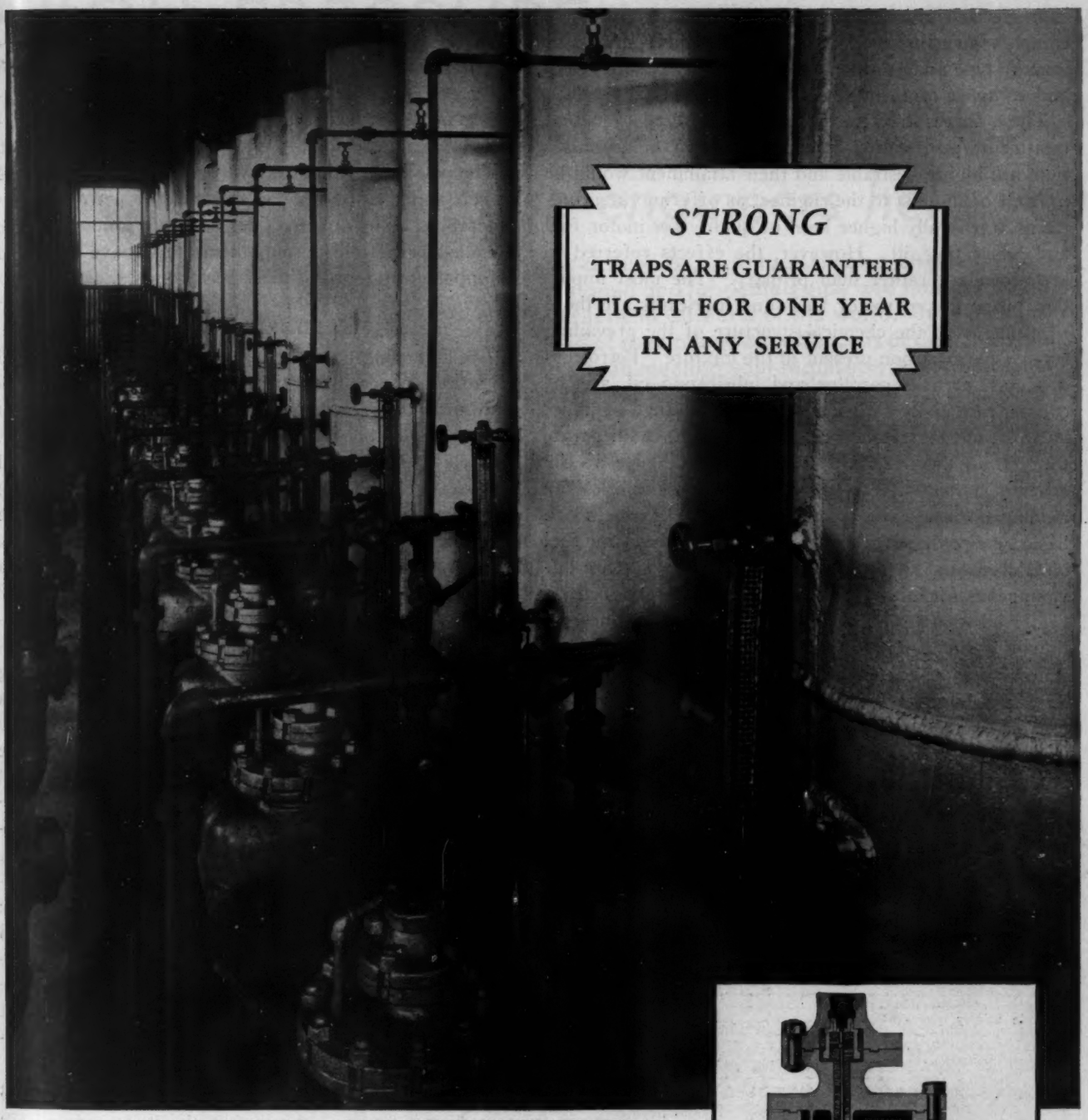
*R. T. Haslam is vice-president and general manager of the Standard Oil Development Company. W. C. Bauer is senior engineer of the fuel and lubricants division for the same company. This paper was presented at the annual convention of the Society of Automotive Engineers.

REACTIONS

According to the conditions of this hydrogenation treatment and the nature of the catalysts employed, the chemical reactions that occur alter their direction and extent. Three characteristic reactions remain unaltered in direction, however, changing only in extent in all cases. The first of these reactions is a species of purification, which has been called by Ellis[1] hydrocarbonization and is defined as the tendency to eliminate from the liquid production of the reaction everything save hydrocarbons. The alien elements, nitrogen, oxygen and sulphur, present in natural hydrocarbons and bitumens are preferentially attacked by the hydrogen so vigorously that they leave the reaction zone as the corresponding gaseous hydrides. Thus, the first and universal result of the hydrogenation process, as regards the character of the products obtained, may therefore be said to be chemical purity. A hydrogenated oil is always a very near approach to a chemically pure hydrocarbon mixture.

The second characteristic reaction is that of stabilization. The hydrocarbons that emerge from the hydrogenation process are by the very nature of the process in all cases chemically stable to a marked degree. Stability is related to, but should not be confused with, chemical saturation or carbon to hydrogen ratio. From the engineer's standpoint stability is measured by actual resistance to chemical change in storage and use, which is character of stability meant here.

The third characteristic reaction is that of homogenizing, by which is meant the tendency to produce a mixture of a more homogeneous nature than the raw material by the preferential reformation of the more-complex molecules present. A hydrogenated oil is in general



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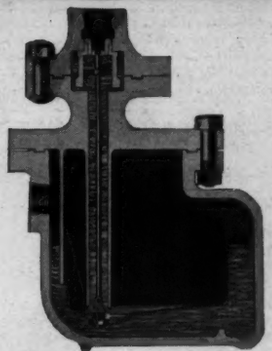

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These three characteristic effects of hydrogenation treatment, purification, stabilization and homogenization, are highly desirable and their attainment would be in itself of interest to the engineer as offering the promise of a generally higher level of quality for motor fuel and lubricating oil. However, the effects referred to are secondary rather than primary. The most important properties of motor fuels and lubricants are those resulting from the chemical structure of the prevailing type of hydrocarbon present in the mixture. Petroleum products, such as gasoline and lubricating oil, are, of course, essentially hydrocarbons but the range of molecular structures extends from the straight-chain paraffin-type on the one hand, to the aromatic type on the other, together with the almost infinite possibilities for modifications and combinations of the two types. Each basic type possesses recognized advantages both for fuel and lubricants. In general, the paraffinic types are advantageous for lubricants while the naphthenic types are preferred for gasoline for use in Otto-cycle engines, although in the commercial production of fuels and lubricants difficulties are encountered which enforce compromise. Paraffinic lubricants as commercially produced give greater and more objectionable carbon deposit than do naphthenic lubricants, while naphthenic lubricants usually give higher consumption and have characteristically a much greater change of viscosity with a change of temperature. In producing naphthenic gasolines the result is usually a less pure and less stable product than the paraffinic gasolines but one that is decidedly superior in antiknock tendency. Crudes that yield paraffinic lubricants seldom, if ever, yield antiknock gasoline.

The possibilities that the hydrogenation process offers of reforming the molecular structure of petroleum hydrocarbons along directed lines to obtain products of the so-called paraffinic or naphthenic type have presented an opportunity to avoid these compromises.

LUBRICANTS

The following data present the actual properties and performance characteristics of hydrogenated gasolines and lubricating oils as tested by the fuel and lubrication laboratories of the Standard Oil Development Company.

Table 1 gives the properties of the hydrogenated and comparative oils used in a series of tests on a White motor truck engine. In this table M and N designate high-grade commercial, paraffin-base, premium-price lubricants, both widely sold and advertised. Oil O is a commercial straight Pennsylvania product, while oils P and Q refer to commercial oils from Gulf Coast naphthenic-base stocks, P being widely distributed throughout the country, while Q is distributed mostly along the Atlantic seaboard. Table 2 presents similar data for the oils used in a series of tests on a heavy-duty Mack motor-truck engine. Here oils A. B. C and D are all premium-price products; A being from straight Pennsylvania paraffin-base crude and B and D from mixed paraffin-base stocks. Oil C is a product from mixed base crude but containing more of the naphthenic type of hydrocarbons. Table 3 gives a comparison of hydrogenated oils with lubricants made from the same crudes by the most up-to-date normal refining methods.

A study of Tables 1, 2 and 3 shows that the hydrogenated oils are in general equal, or superior, to all others in the relationships that are the usual indications of quality. In general, the gravity of the hydrogenated oils of a given viscosity at 210°F. is high. Their flash and fire-points are higher than those of any other oils. Pour test in both hydrogenated oils and natural products depends almost wholly on the nature of the stock and the extent of dewaxing. Without excessive finishing the hydrogenated oils are of a high color. The Conradson carbon-residue is

TABLE 1—PROPERTIES OF OILS USED IN WHITE MOTOR-TRUCK ENGINE TESTS

Oil	Hydrolube 75	M	N	O	P	Q
Gravity, A.P.I. deg.	26.3	24.8	25.2	27.8	21.3	19.0
Flashpoint, deg. F.	500	440	445	425	445	440
Fire test, deg. F.	585	500	520	480	520	...
Viscosity at 100° F., Saybolt sec.	810	747	741	651	1,400	1,356
Viscosity at 210° F., Saybolt sec.	75.5	74	74	75	80	75
Pour test, deg. F.	10	25	40	30	0	10
Color (Robinson)	9¼	¾	1	2	1½	5
Conradson carbon-residue, per cent	0.161	1.259	0.899	0.964	0.849	0.113
Organic acidity, per cent	Trace	0.1	0.1	...	0.1	0.16
Sulphur, per cent	0.16	0.40	0.40	...	0.34	0.37
Steam emulsion No., sec.	300	360	480	240	1,200+	300
Viscosity index	86	90	90	100+	27	5

TABLE 2—PROPERTIES OF OILS USED IN MACK MOTOR-TRUCK ENGINE TESTS

Oil	Hyrdo-genated M	Hydro-genated C	A	B	C	D
Gravity, °A.P.I.	29.5	27.3	28.4	22.9	21.5	24.9
Flash point, °F.	485	460	420	415	415	425
Fire test, °F.	560	540	470	485	475	485
Viscosity at 100° F., Saybolt sec.	478	523	491	575	603	492
Viscosity at 210° F., Saybolt sec.	63	62	66	60	60	61
Pour test, °F.	20	0/No	10	10	0/No	30
Color (Robinson)	19¼	2½	2¾	¾	6½	1¼
Conradson carbon-residue, per cent	0.027	0.065	0.810	0.277	0.276	0.482
Organic acidity, per cent	Trace	Trace	Trace	0.07	0.05	0.06
Sulphur, per cent	0.050	0.118	0.120	0.340	1.448	0.350
Steam emulsion No., sec.	90	540	210	180	120	510
Viscosity index	100	84	108	58	50	87

TABLE 3—COMPARISON OF HYDROGENATED AND NORMAL OILS FROM SAME CRUDES

	—Mid-Continent—		——Colombia——	
	Normal	Hydro-genated	Normal	Hydro-genated
Gravity, °A.P.I.	24.9	29.5	22.7	27.3
Flash point, °F.	415	485	410	460
Fire test, °F.	490	560	475	540
Viscosity at 100° F., Saybolt sec.	530	478	510	623
Viscosity at 210° F., Saybolt sec.	62.5	63	55	62
Pour test, °F.	25	20	0/No	0/No
Color (Robinson)	2¾	19¼	3¾	2½
Conradson carbon-residue, per cent	0.482	0.065	0.186	0.065
Organic acidity, per cent	0.064	Trace	Trace	Trace
Sulphur, per cent	0.39	0.05	0.78	0.19
Viscosity index	82	100	35	84

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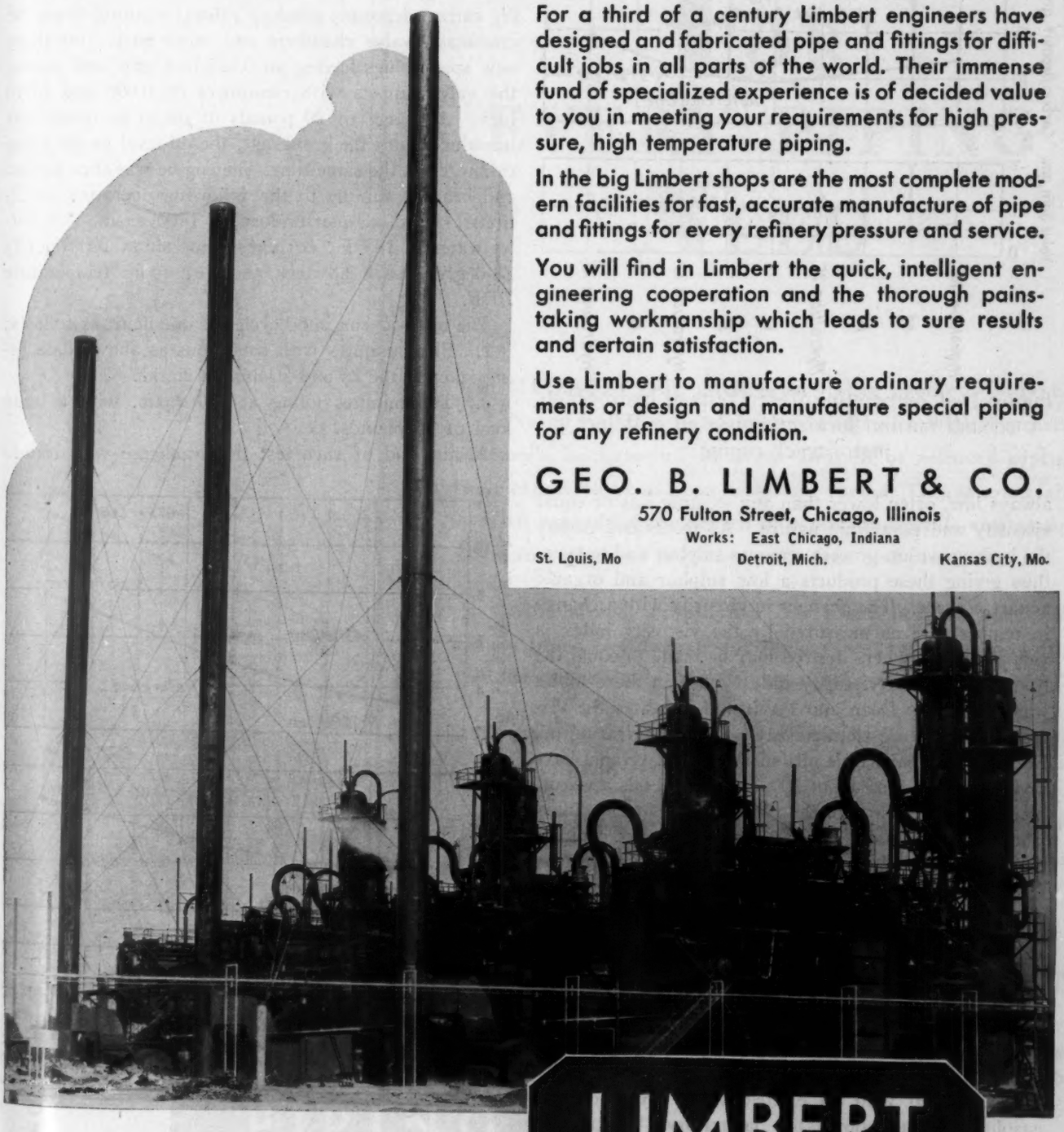

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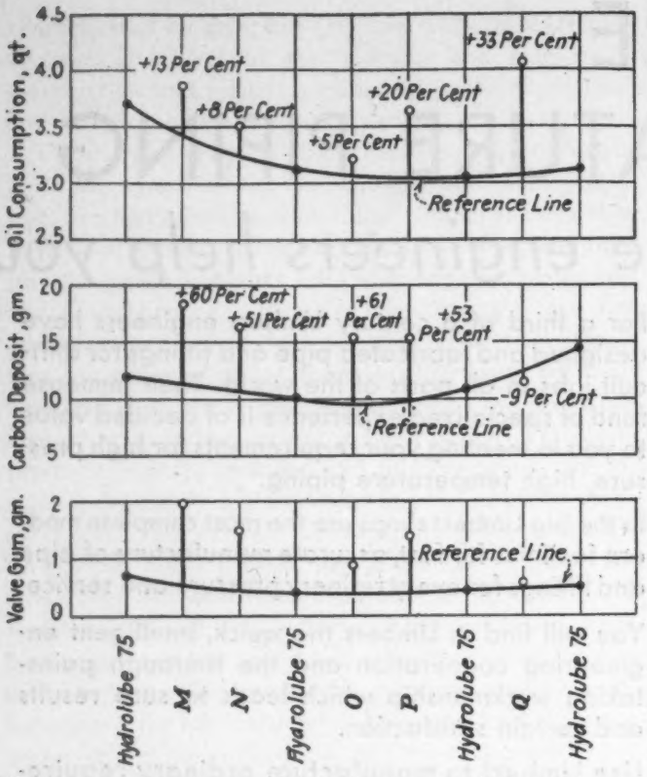


Figure 1—Comparative 50-Hr. tests of hydrogenated and natural lubricating-oils on a White motor-truck engine

always low, often lower than any existing oils of equal viscosity and paraffinic nature. As mentioned earlier the hydrogenation process removes sulphur and oxygen, thus giving these products a low sulphur and organic acidity content. The changes in viscosity with a change in temperature as measured by the viscosity index is very good and where desired may be made to equal the best. The term "viscosity index" used in these tables was devised by Dean and Davis and indicates the viscosity-temperature characteristics of the lubricating oil. For example, paraffinic oils such as Pennsylvania have a viscosity index of about 100, and coastal oils a viscosity index of from 0 to 20. Thus, from the ordinary laboratory inspection, satisfactory performance could be expected for the hydrogenated oils. Two series of these tests reported below show that this expectation was completely borne out.

MOTOR TRUCK TESTS

The White motor-truck engine tests were made on the Model GRB which has four cylinders of 4¼" x 5¾" and was equipped with a OE-2 Stromberg carburetor and ZR-4 Robert Bosch magneto. Engine power was measured with an electric cradle dynamometer; gasoline consumption, by laboratory burette apparatus; temperatures of air, water, oil, crankcase, fuel and air-fuel mixture, by thermocouples and thermometers; exhaust-gas analyses, by bubble-type Orsat; spark advance, by a noen-tube indicator; oil level, by a special laboratory type level gauge; speed, by a Hasler tachometer and by a positive revolution counter and stopwatch; intake-manifold depression and exhaust back pressure, by special manometers; and air condition, by barometer and hygrometer. A special throttle-setting device was used to insure positive settings. Carburetor-air temperatures were held at 100°F. plus or minus 2 degrees with an automatic electric heater, while outlet-water temperatures were also controlled automatically at 185°F.

The engine was put in first-class condition by removing carbon deposits; grinding valves; washing down the crankcase, valve chambers and other parts; installing new spark plugs having an 0.025-inch gap, and setting the valve tappets with clearances of 0.008 and 0.010 inch. A charge of 20 pounds of oil to be tested was introduced into the crankcase, the oil-level gauge being calibrated at the same time. The engine was then started and brought rapidly to the following operating conditions: (a) three-quarter load at 1400 r.p.m. (b) outlet water at 185°F., (c) carburetor air at 100°F., (d) 28-degree spark advance and (e) room temperature 70°F.

The test was run in 50 cycles of one hour, as follows:

1. Fifty minutes with conditions as above, data being taken at the 25 and 50-minute marks.
2. Ten minutes idling at 450 r.p.m. with a beam load of 25 pounds.

At the end of each test the crankcase was drained

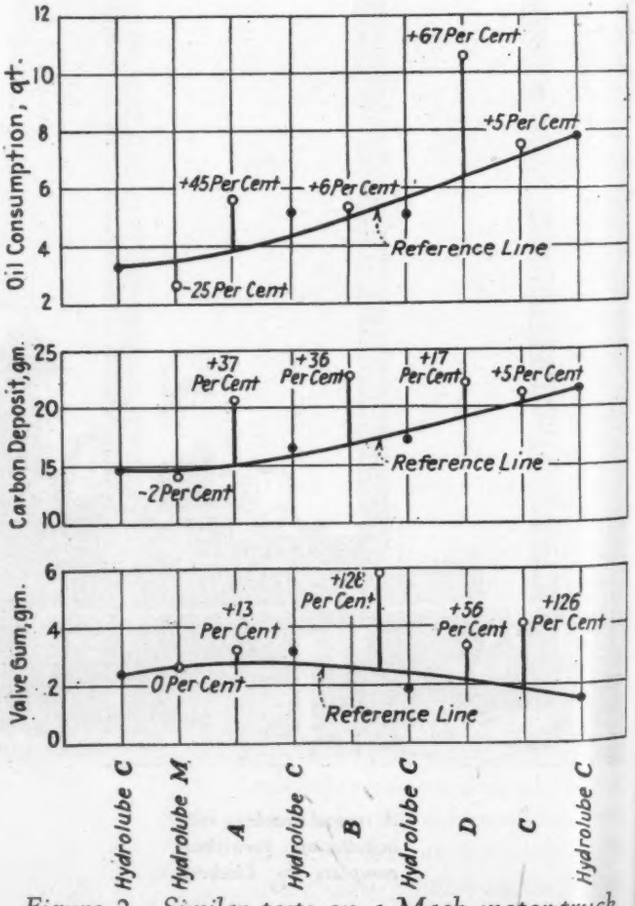
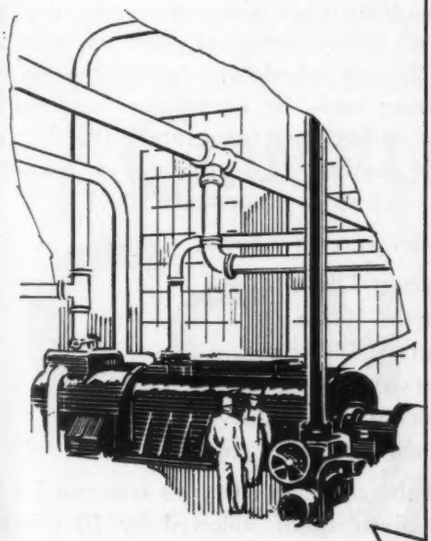


Figure 2—Similar tests on a Mack motor-truck engine

FOR EVERY PIPING NEED



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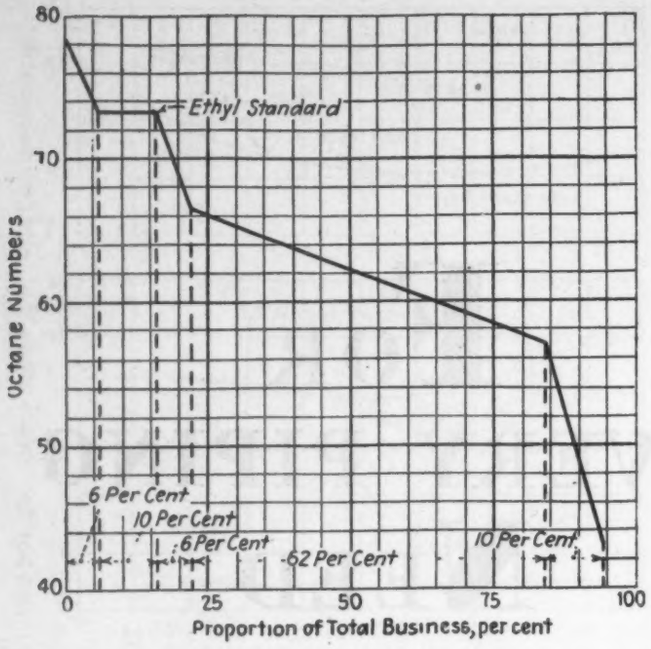


Figure 3—Survey of gasoline sales in the United States on the knock-rating basis

while hot, after which it was removed and the stray oil collected. The inside of the engine and the crankcase were then washed down with kerosene, after which the bearings and cylinder walls were sprayed with the next oil to be tested. The cylinder heads were removed, the carbon collected, valve gum removed and the valves then reground. The engine was then assembled and prepared for the next test.

The first and, thereafter, every third oil tested was a hydrogenated oil, identified as Hydrolube 75, which was used as the reference oil. The frequent runs on this oil served to give a truer comparison with the other oils tested by giving an index of the engine changes occurring as the tests progressed. The comparisons are made by referring the oils in question to the curve connecting the reference-oil points.

TABLE 4—RESULTS OF WHITE MOTOR TRUCK ENGINE TESTS

Oil	Oil consumption as compared with hydrolube per cent	Carbon in engine as compared with reference oil, per cent	Valve gum in excess of hydrolube reference oil, gm.
Hydrolube 75	100	100	0.0
M	112	160	1.3
N	108	151	0.9
O	105	160	0.5
P	120	146	0.9
Q	120	191	0.0

The interesting results of this series of tests are given in Table 4 and plotted in Figure 1. The carbon deposition of the combustion chamber and the oil consumption are given in terms of percentages either side of the Hydrolube reference line. The fact will be noticed that, as regards oil consumption, the Hydrolube was better than any of the other oils tested, these being representative of the best grades available today. The carbon deposited by the Hydrolube was less than that of any of the other oils except one of the coastal naphthenic type, which had a high oil consumption. The weight of gum deposited on the valves was lowest with the Hydrolube and the same coastal oil. These results indicate that, with a conventional low-speed engine which does not run excessive crankcase-oil temperatures, the Hydrolube on the whole showed an improvement over the natural oils. Its performance may be characterized as follows: consumption lower than the best paraffin-base Pennsylvania lubricants and carbon deposit in the engine comparable with that obtainable with coastal stocks. In general, the carbon deposit was proportional to Conradson carbon residue.

Because of the difficulty in satisfactorily lubricating heavy-duty, high-speed motorcoach engines, we decided to run a series of tests under abnormally severe conditions on a 3⅜" x 5" six-cylinder engine of this type. To make these tests as severe as desired the engine was placed in a room maintained at a constant temperature of 100°F.; the fan was removed from the engine to eliminate this upper crankcase cooling; no cooling provision was made for the oil in the lower crankcase; and to aggravate both oil consumption and carbon formation the lower of the two oil rings on the piston was removed.

The auxiliary apparatus was practically the same as for the White motor-truck engine tests previously described except that the conditions of operation were altered to the following schedule: (a) Three-quarter throttle, the setting made by horsepower readings at 1600 r.p.m.; (b) outlet-water temperature 185°F.; (c) spark advance 24 degrees; (d) carburetor-air temperature 100°F., and (e) room temperature 100°F.

The speed cycles were as follows:

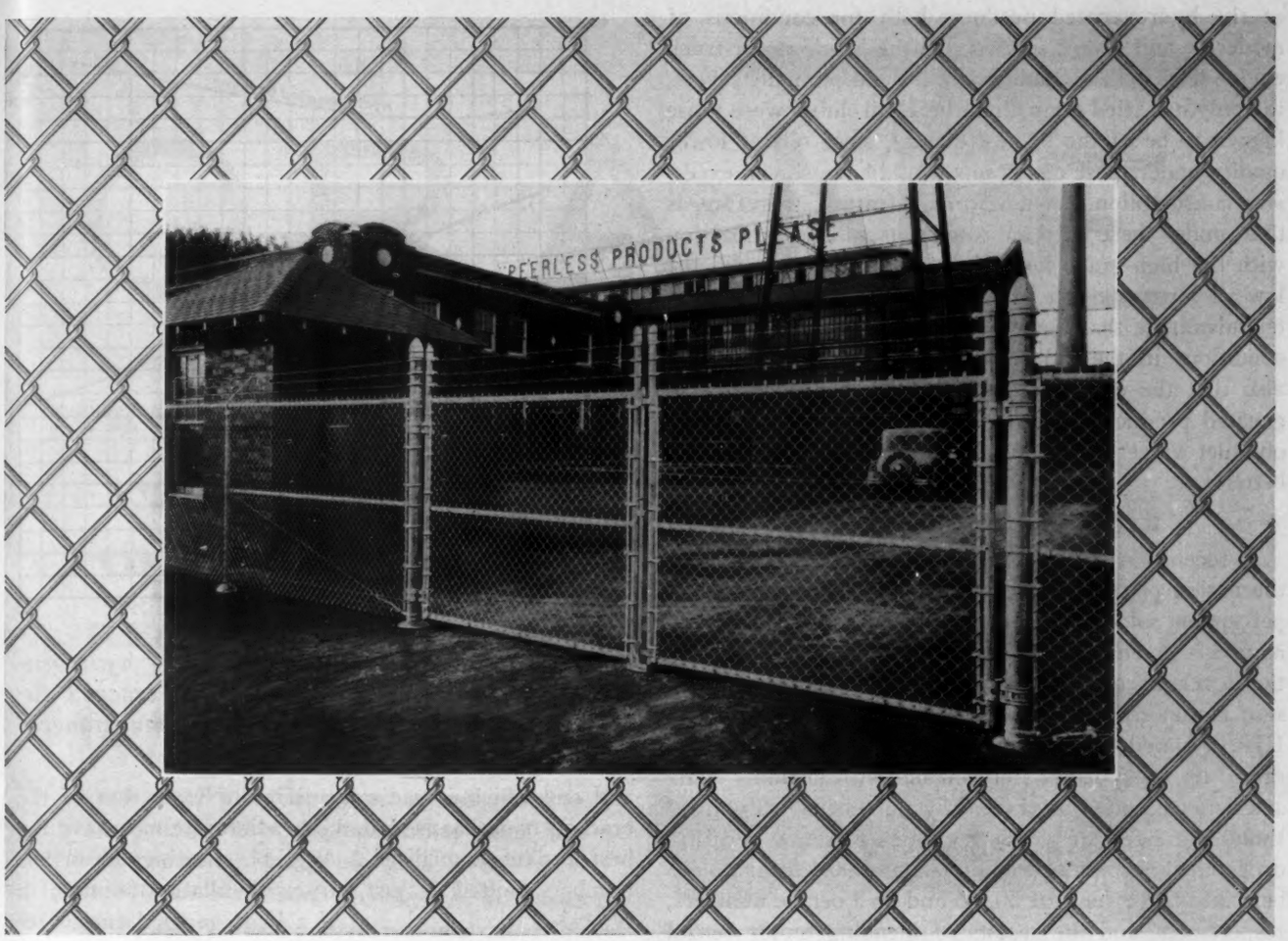
1. Seven hours at 1200 r.p.m.
2. Eight hours at 1600 r.p.m.
3. Seven hours at 1400 r.p.m.
4. Eight hours at 1600 r.p.m.
5. Seven hours at 1800 r.p.m.
6. Thirteen hours at 1600 r.p.m.

Each hour of the above speed cycles was run for 50 minutes at the given speed followed by 10 minutes idling at 400 r.p.m. with a beam load of 10 pounds.

As in the White motor-truck engine tests the first oil and every second or third oil thereafter was a hydrogenated oil, designated as Hydrolube 62 and made from Colombian crude. All comparisons between oils are made by reference to their position to the base line connecting the reference-oil points. In this way engine changes between tests are compensated.

Table 5 shows oil consumption, carbon formation within the engine and gum formation on the inlet valves. Figure 2 shows these same results plotted. The two hydrogenated products show performance characteristics superior in all respects to those of the other oils tested.

These last tests taken in connection with the tests on the White motor-truck engine indicate the superiority



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of the hydrogenated products both for conditions of moderate and severe service. In the Mack motor-truck engine tests, where conditions were exceptionally severe, the only oils tried other than the Hydrolubes were those known to be of the highest quality, since oils of lower quality under these conditions would have shown excessive consumption. A noteworthy feature, therefore, is that, under these extreme conditions and in comparison with the high-grade natural products, not only did the low oil consumption of the Hydrolubes show up to better advantage than under the more moderate operating conditions in the White motor-truck engine tests but also that the condition of the engine with the hydrogenated products, as shown by carbon formation, gum on inlet valves, wear and general inspection, was the better.

HYDROGENATED GASOLINES

A recent estimate of gasolines marketed throughout the nation plotted on the basis of knock rating against percentage sold is shown in Figure 3. This same information is given in Table 6. This clearly illustrates why the development of higher efficiency, higher compression automotive equipment has been so much delayed. Hydrogenated gasolines have been made with a knock rating up to 95 octane number and with blending characteristics as good as chemically pure benzol. Figure 4 shows the effect of blending various percentages of hydrogenated gasolines of 83.2, 87.7 and 90.4 octane numbers into three fuels of 50, 60 and 66.5 octane numbers, respectively, and the results of blending motor benzol into the same fuels are also plotted. The properties of these blending stocks are given in Table 7.

Another characteristic of these hydrogenated fuels

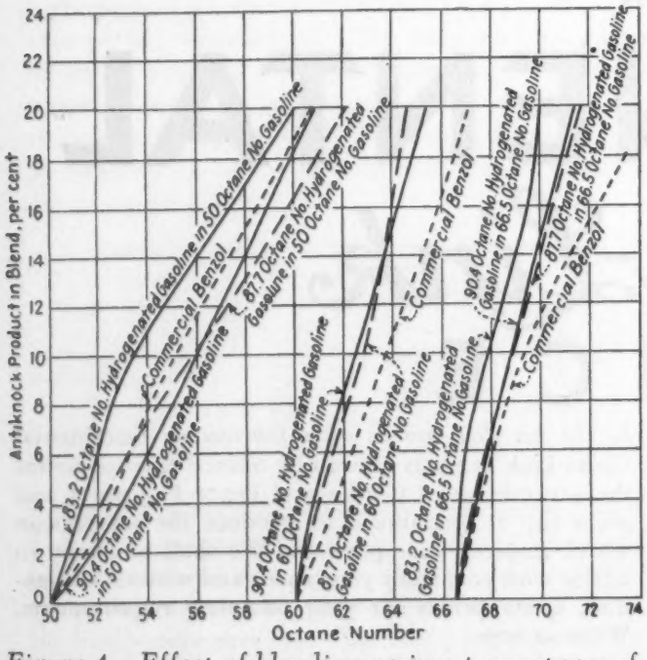
Antiknock Product in Blend, per cent
Octane Number
83.2 Octane No. Hydrogenated Gasoline in 50 Octane No. Gasoline
Commercial Benzol
87.7 Octane No. Hydrogenated Gasoline in 50 Octane No. Gasoline
90.4 Octane No. Hydrogenated Gasoline in 50 Octane No. Gasoline
90.4 Octane No. Hydrogenated Gasoline in 60 Octane No. Gasoline
87.7 Octane No. Hydrogenated Gasoline in 60 Octane No. Gasoline
83.2 Octane No. Hydrogenated Gasoline in 66.5 Octane No. Gasoline
90.4 Octane No. Hydrogenated Gasoline in 66.5 Octane No. Gasoline
87.7 Octane No. Hydrogenated Gasoline in 66.5 Octane No. Gasoline

Figure 4—Effect of blending various percentages of Hydrogenated gasolines of octane numbers 83.2, 87.7 and 90.4 and commercial motor benzol into fuel having octane numbers of 50, 60 and 66.5

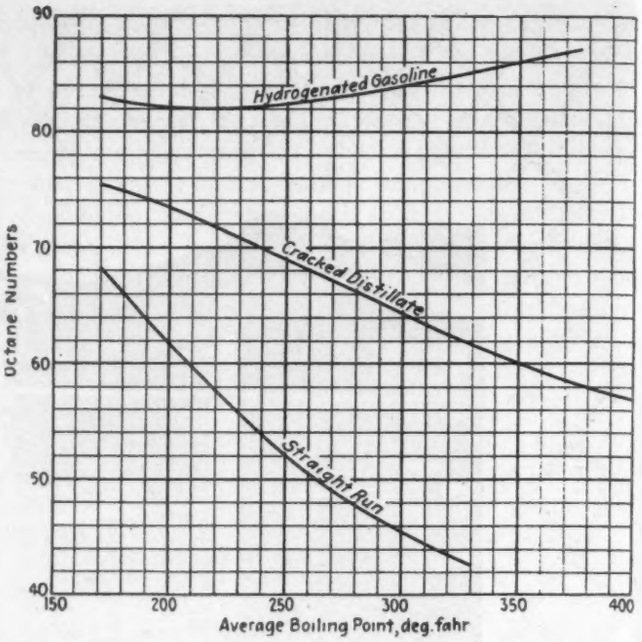

Figure 5—Anti-knock characteristics of hydrogenated gasoline, straight-run gasoline and cracked distillate plotted as a function of the boiling range.

and one which is radically different from that of the cracked naphthas is that the heavier fractions have the best antiknock qualities. A graph showing the octane numbers plotted against various distillation points of a typical cracked stock and of a hydrogenated fuel is reproduced as Figure 5. The Otto-cycle, air-cooled aviation engine has the advantage of very light weight per horsepower delivered, with the disadvantage of using a very volatile fuel of very low flashpoint. The Diesel-cycle engine has a greater weight per horsepower but a safety advantage in that a high-flashpoint fuel is used. For positive fuel injection and atomization an Otto-cycle engine cannot advantageously use present non-volatile fuels because of their severe detonating characteristics. Hydrogenation gives a high-flash fuel, or extremely good antiknock value, making possible developments of this nature, particularly in the airplane and marine fields.

Hydrogenated gasolines are also very sensitive to the addition of tetraethyl lead. Table 8 gives the octaine numbers, at 212° and 300°F. of several aviation gasolines made by different processes. The quantity of tetraethyl lead required at both 212° and 300°F. to brings these fuels to the Army Air Corps specification of 87 octane number is also given.

Hydrogenated fuels have characteristically low sulphur contents, the average being less than 0.03 per cent. Much controversy has arisen concerning sulphur in gasolines. Most of the experimental work has been limited to a study of engine corrosion. Insufficient results have, as yet, been reported on the effect of sulphur content on carbon deposition, of lead-sulphate deposition on exhaust valves when tetraethyl lead is used and

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Nickel Alloy Steel is employed because its toughness, hardness and strength insure unfailing service even under high pressures at elevated temperatures. Another important feature of Nickel Alloy Steel is its resistance to the corrosion caused by highly corrosive oils.

Extensive tests have shown that the average, maximum and minimum values of Nickel Alloy Steels vary less from heat to heat than those of other commercial steels. This uniformity is especially desirable in the manufacture of equipment where it is impractical to test each piece of steel used.

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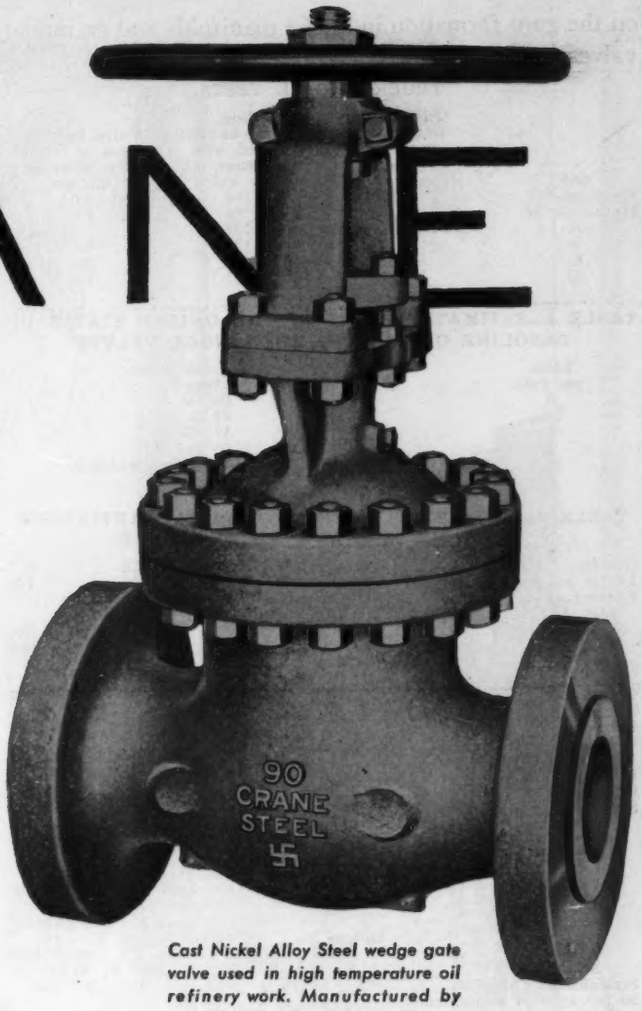
Information on the properties and applications of Nickel Alloy Steels will be gladly furnished by our staff of engineers.



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on the gum formation in intake manifolds and on intake valves.

TRUCK ENGINE TESTS

Oil	Oil consumption as compared with hydrolube per cent	Carbon in engine as compared with reference oil, per cent	Valve gum in excess of hydrolube reference oil, gm.
Hydrolube C	100	100	0.0
Hydrolube M	75	98	0.0
A	145	137	0.3
B	106	136	3.4
C	105	105	2.2
D	167	117	1.4

TABLE 6—ESTIMATED SALES IN THE UNITED STATES OF GASOLINE OF VARIOUS ANTI-KNOCK VALVES

Sales per cent	Antiknock value, octane No.
6	Below 43
10	43 to 57
62	57 to 66
6	66 to 73
10	73 (Ethyl standard)
6	Above 73

TABLE 7—PROPERTIES OF HYDROGENATED ANTIKNOCK GASOLINE USED AS BLENDING STOCK

Gravity, °A.P.I.	45.1	47.2	45.7
Initial distillation point, °F	92	95	106
Percentage distilled at			
140° F.	14.0	12.0	...
158° F.	20.0	18.0	9.0
212° F.	34.0	36.0	26.0
284° F.	51.0	58.0	55.0
356° F.	73.5	78.0	90.0
90 per cent point, °F.	384	384	356
Endpoint,° F.	410	422	406
Recovery, per cent	99.0	99.0	99.0
Octane No.	82.8	88.0	90.0
Dissolved gum, gm.	19.6	3.9	5.2
Induction period, hour	2.0	1.1	1.6
Color (Robinson)	23	22	23
Sulphur, per cent	0.017	0.016	0.020

TABLE 8—OCTANE NUMBERS OF VARIOUS AVIATION GASOLINES

Stock—	Octane No. 212° F.	Octane No. 300° F.	Lead required to equal 87 octane No.,cc. 212° F.	Lead required to equal 87 octane No.,cc. 300° F.	Octane No. change per cc. of lead at 300° F.
Straightrun California	76	76	1.6	1.5	7.3
90 per cent of straightrun California and 10 per cent of benzol	79	75	1.1	1.2	10.0
Straightrun Smackover	74	72	2.7	3.8	4
Vapor-phase cracked Texas.	75	73	3.6	4.2	3.3
Hydrogenated Aviation A..	80.4	79	0.7	0.9	9.0
Hydrogenated Aviation B..	74.8	73.5	1.1	1.7	8.0

The properties of the blending stocks given in Table 7 show the hydrogenated fuels to have low gum content and also by the oxygen-bomb test to be very stable. This bomb test consists in placing a small quantity of fuel in a gas-tight steel bomb and subjecting it to 100-pound pressure of oxygen. After testing the bomb for leakage it is coupled to a pressure-recording gauge and placed in a steam bath. The time from maximum pressure until a drop of five pounds occurs is called the injection period and is a measure of the fuel's stability. A fuel that will stand up 1½ hours under this test is exceptionally stable.

SUMMARY

The tests here referred to show that hydrogenated lubricating oils made from available common crudes are superior to the highest grade of natural lubricants now available to the automotive industry.

High-grade naphthenic gasolines and blending stocks are produced by hydrogenation from relatively low-grade gas oils, these highly antiknock blending stocks having iso-octane numbers of from 90 to 95 and a blending value in commercial gasoline equal to pure benzol. They are low in gum and sulphur and are gum and color stable. They are excellent stocks for use with tetraethyl lead, since the lead susceptibility is good, being considerably better than for most cracked products.

The process of hydrogenation, when widely adopted by the petroleum industry, apparently will open up to the automotive engineer the the possibility of designing engines for operating at greater compressions, higher speeds and higher temperatures, resulting in a marked gain in efficiency.

The Compression of Hydrocarbon Gases

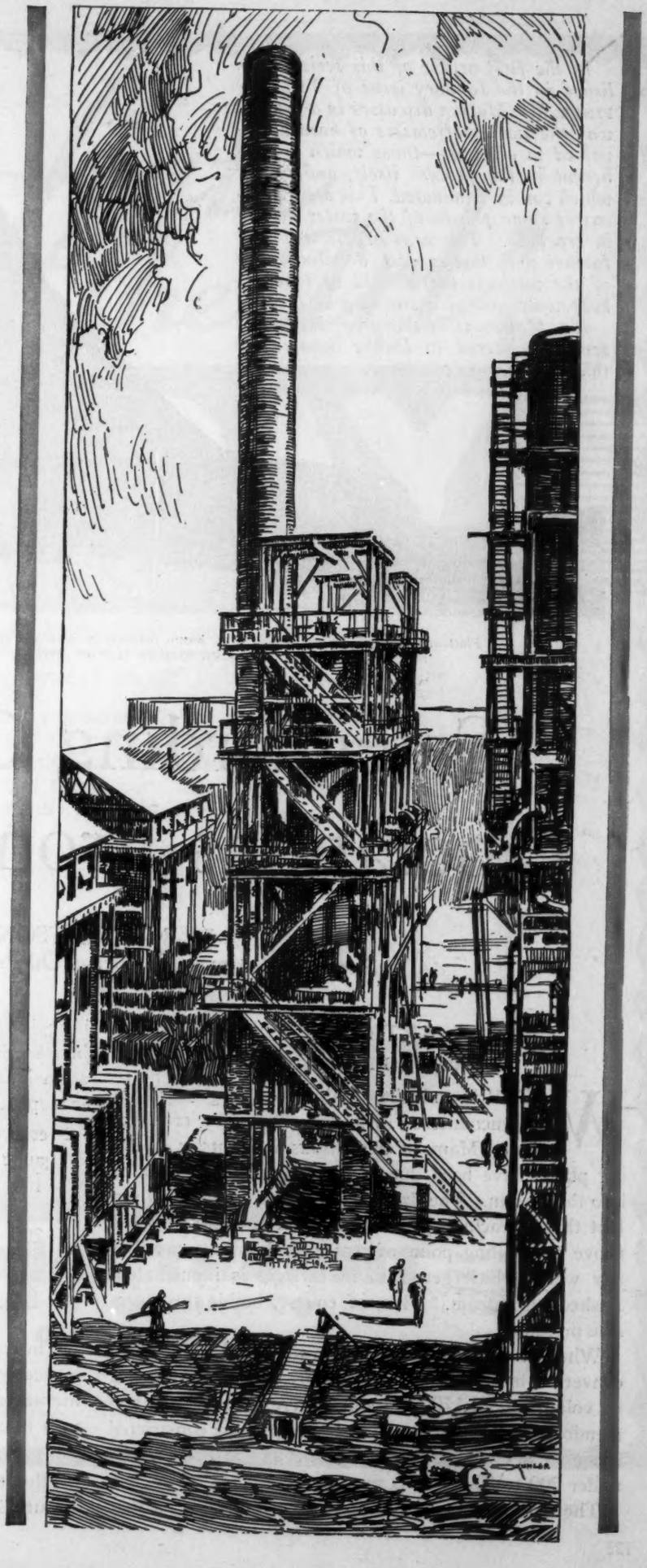
(*Continued from page* 108)

mitted to thermal analysis. Equations of state specifically adapted to the hydrocarbon gases will be treated more fully in a later article devoted exclusively to the subject.

COMMENT AND DISCUSSION

The thermal properties of the gaseous hydrocarbons together with the pressure-volume relationships are matters of highly practical as well as theoretical interest. The perfection of mechanical equipment for the conversion of heat into work through the use of steam, in no small measure, has been dependent upon the experimentally determined properties of this medium. Millions of dollars are invested in equipment for the compression of natural gas, yet there is practically no trustworthy data generally available on specific heats, or pressure-volume relationships at higher pressures. Thermal capacities of hydrocarbons as effected by increase of pressure, have an important bearing upon their chemical reactivity. In view of the wide-spread interest in oxidation, hydrogenation, and thermal decomposition together with the present growth of natural gas transmission systems, it is surprising that so little fundamental data are to be found.

The ratios of specific heats at constant pressure and volume for the higher temperature and pressure ranges for the hydrocarbons would be of great value. The viscosity of gases which increases rather than decreases on temperature rise, probably has an important bearing upon the chemical as well as the physical properties of a gas. All in all the present available fundamental chemical and physical data relative to the hydrocarbon gases, are badly in need of both revision and extension.



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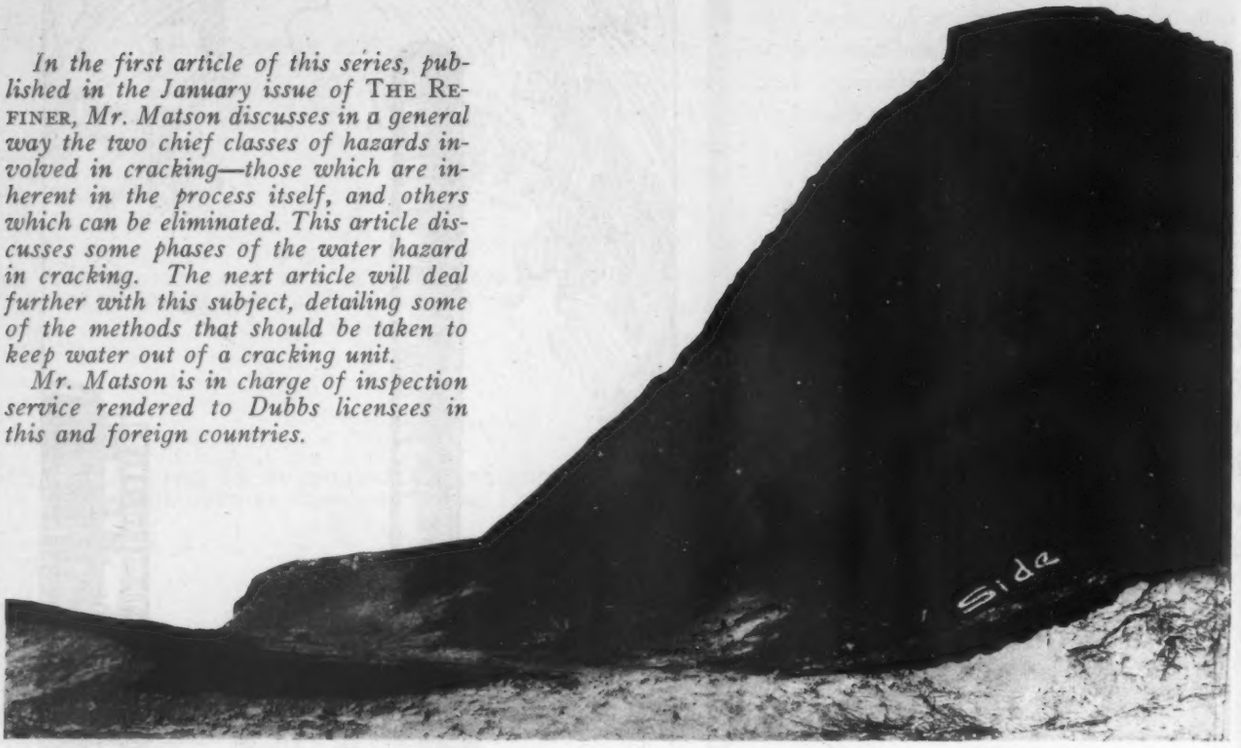
In the first article of this series, published in the January issue of THE REFINER, *Mr. Matson discusses in a general way the two chief classes of hazards involved in cracking—those which are inherent in the process itself, and others which can be eliminated. This article discusses some phases of the water hazard in cracking. The next article will deal further with this subject, detailing some of the methods that should be taken to keep water out of a cracking unit.*

Mr. Matson is in charge of inspection service rendered to Dubbs licensees in this and foreign countries.



Flattened out cylindrical portion of a heavy pressure vessel—a result of sudden pressure impulse due to rapid vaporization of water pocketed therein

Safeguarding Cracking Operations From Accident

By E. M. MATSON
Service Department, Universal Oil Products Company

ARTICLE 2

DANGERS FROM WATER

WATER is undoubtedly the most dangerous hazard encountered in the operation of a cracking plant. Many of the serious accidents in cracking plants have been due to the introduction of water into the system. The danger, of course, arises from the fact that a cracking plant operates at temperatures far above the boiling point of water, and this means that any water which gets into the system is immediately flashed into steam. This, of course, builds up excessive pressure.

When it is considered that water at 212°F. when converted into steam, at atmospheric pressure, expands its volume about 1700 times, it is easy to realize the tremendous pressures that can be built up in the constricted space of a cracking unit operating say at 850°F. and under 200 to 300 pounds pressure or higher.

The significance of this expansion effect is further brought out in the accompanying table which shows the increase in volume of water when converted into steam at various pressures and temperatures common to cracking operations.

Pressure gauge	Temperature °F.	Volume increase
100	750	387 times
	850	420 times
200	750	205 times
	850	224 times
500	750	82 times
	850	91 times

The resistance offered by the equipment to this increase in volume means increase in pressure and increases the stresses in the material of which the unit is constructed.

The sudden release of this energy through failure of the equipment produces a disastrous explosion. Figure 1, which shows the cylindrical section of a

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Yesterday some high grade refinery engineers would not consider the installation of gas engines to be operated on refinery gases. And at that, their judgment was good, it being based on the "state of the art" in building gas engines.

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ruptured heavy walled pressure vessel, is illustrative of what may occur in such a case. This section is part of a vessel which actually was wrecked in such an explosion.

The sudden rupture of a vessel containing hot oil and vapor generally means death or serious injury for men working nearby, as well as great destruction of property.

Death or injury may be caused by the concussion, by fire, or from flying objects thrown by the explosive force.

That there have been few really serious accidents in the history of cracking speaks well for the care with which units have been operated. But the loss of life and property that has resulted in these few disasters makes it well worth while to take every possible precaution against such accidents.

The operating pressure of a cracking still can be effectively controlled under all usual conditions within the limits for which the equipment is designed.

Devices for maintaining this control are standardized and are generally well understood by operating men. When the pressure rises above what it should be for normal operation, due to operating irregularities, carelessness of attendants or other causes, relief or unloading valves provided for the purpose usually are enabled to reduce the pressure to safe limits before an accident results.

There is a time element also in such cases which works to prevent accidents. That is, there is generally sufficient length of time between the start of the abnormal pressure rise and the danger point to permit the operating crew, if alert, to take emergency measures to relieve the mounting pressure.

KEEP WATER OUT

The only cure for pressure rise due to water is to keep the water out. The water flashes instantaneously, leaving no time for any remedial measures. Of course, the seriousness of the results depends upon the amount of water introduced into the system, and its concentration, but a comparatively small amount is likely to produce serious consequences.

Serious though the water hazard may be, it is not classed among those which are inherent in a cracking system as described in the first article of this series. Water can be kept out of a cracking unit by due diligence of the operating crew at all stages of the operation.

As stated in the first article, there are a number of ways in which water can get into a cracking unit. The most common ways are through charging of oil which contains water in the form of emulsion which has not settled out in the storage tank, or in the form of slugs which the charging pump may draw by accident from the bottom of a tank, or by accumulation of condensed water on the interior walls of receptacles and piping in the system following a cleanout. Water introduced with the feed during operation is likely to cause damage either in the heating tubes in the furnace or in the dephlegmator, according to which method of feed is used.

The three chief cares of every cracking plant operating crew should be, first, to prevent charging the cold cracking unit with oil containing water; second, to get rid, during the heating up period, of water that may have collected in low places in the apparatus after cleaning out and during charging; and third, to prevent water from being drawn in with the feed while the unit is operating.

In one case, more than a barrel of water was found in the bottom of a reaction chamber when it was being brought on stream. This amount of water might have caused a serious accident if it had not been discovered before it reached excessive temperature.

While the water remaining in the system after cleaning out is usually small in amount, it may cause trouble unless it is drained out. Water that condenses, as stated above, on the surfaces of dephlegmator pans, chamber walls, and on the inside of piping, drips off and runs down to collect, sometimes in considerable amount, in the reflux leg, in the surge bends of hot oil pumps, or the liquid cylinders of other type hot oil pumps.

Water fed into the system in emulsified form will vaporize and find its way eventually into the distillate receiver tank, having been condensed in the pressure distillate condenser coils.

When pressure distillate is drawn from the receiver tank for refluxing over the dephlegmator, water may be introduced into the dephlegmator with the reflux oil.

SOURCES OF WATER

Some ways in which water may enter a cracking unit are given in detail as follows:

With the ram pump, especially when it takes suction from a special ram pump stock tank; from water and steam connections to the system; and from condenser and residuum cooler box coils.

Charging stocks may be crude, residual oils, overhead cuts, distillate or a mixture of these with slops and trap skimmings. Crude oil from a tank farm or pipe line may and usually does carry some water either free or as an emulsion.

Topped crudes or fuel oils from the skimming plant may be contaminated with water when discharged to tanks other than the charging stock tanks especially if such tanks are also used for slop and trap skimmings on the light oil side.

Topped crude from the refinery skimming plant when discharged directly to the charging stock tanks may pick up water from leaky cooler box coils particularly when the pump is located on the outlet side of the cooler box.

Topped crude or other charging stock from "for-

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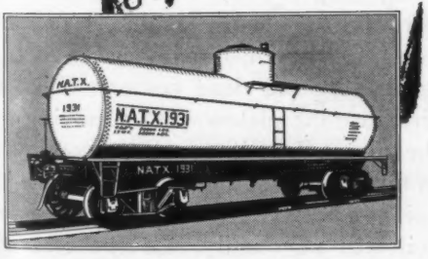

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IS SOUND BUSINESS ECONOMY

eign" plants may contain water when delivered to the charging stock tanks.

Charging stocks may also be contaminated with water in its transfer from tank to tank before reaching the cracking plant due to: Leaky or broken swing suction connections; leaky steam coils; rain water through leaky tank roofs and open hatch covers; discharge of slop and trap skimmings to tanks containing charging stocks; previous use of transfer pump for pumping water, or through leaky valves in lines to the transfer pump header, which may be employed for water transfer or for oil which may possibly carry water; and by emulsions which are not broken down during skimming or other processing prior to cracking, and which, therefore, remain in the charging stock.

If the method of operation involves recirculation at the start of the run or during the warming up period from the system and back to the charging tank through a cooling coil, water may be picked up through a leak in such coil which may have allowed water to enter it during the shut-down or clean-out period. This water will be forced into the charging tank unless separate recirculating tanks are provided.

Fixed steam and water connections to a system may also be a source from which water may get to the charging stock tanks. This may come about through misoperation of the block valve on such a line when the pressure on the system during the start of the run is still below the steam or water pressure. On recirculation this water will find its way back to the charging tanks, (if the recirculation is from the lowest point of the system).

From the foregoing it should be apparent that there are many ways in which water may find its way into the charging stock tanks and thence into the system, and that much care must be used to prevent the entrance of water.

Operation of Diesel Engines

By H. S. PETERS*

THE distinguishing feature of the Diesel engine is that the air charge is compressed to a high pressure such that the resulting temperature of the air is above the self-ignition point of the fuel oil. As a consequence the oil when introduced into the cylinder is ignited by the high temperature. The fuel is introduced at such a rate that the pressure does not rise above the compression pressure. Originally Dr. Diesel contemplated introducing the oil at a rate that allowed the heat created by the burning fuel to just equal the work done on the piston. If this had been possible the temperature during combustion would have been constant. As it is, the temperature rises while the pressure is either constant or experiences a slight drop. For this reason the Diesel engine is known as a constant pressure engine. The exhaust or heat discharge is theoretically at constant volume, although part of the heat is thrown out during the exhaust stroke at constant pressure.

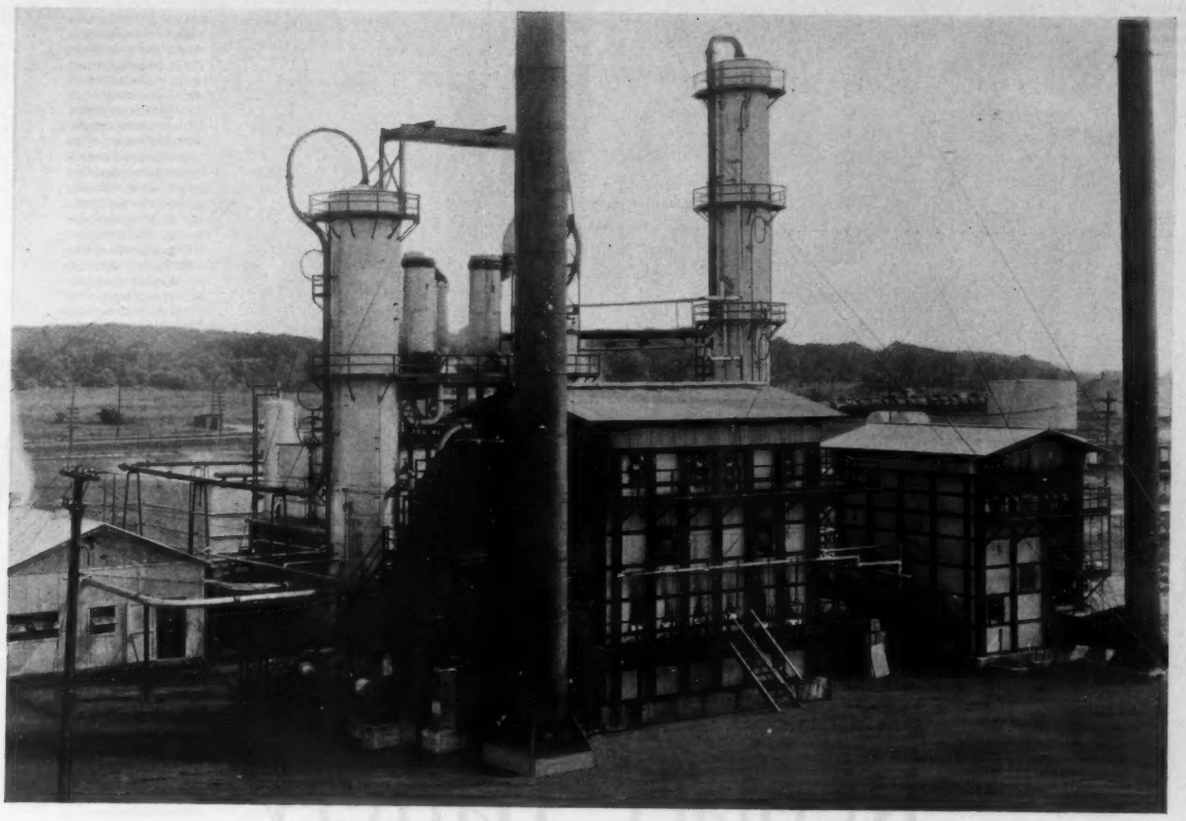
In visiting oil engine plants many Diesels 10 to 15 years old are often encountered. The majority of these old engines have never had a reasonable amount of care. Usually, the pistons are so badly worn that the compression is seldom above 300 pounds per square inch. On starting, the air blows down past the pistons so that it is difficult to turn the engine over fast enough to secure ignition.

Many operators, not realizing the danger, are in the habit of giving the cylinder a shot of gasoline. The gasoline is poured in through the admission valves. The engine, even though just barely turning over, will fire the gasoline in the firing cylinder. There is grave danger in this procedure. The gasoline will quite likely explode early in the compression stroke. If this occurs, something is going to give way. For the relief valves, fitted to the cylinder heads, may fail to open. Frequently, admission valve cages are blown out, connecting-rods bent and crankshafts fractured.

There is no disputing the fact that it is extremely difficult to start a badly worn engine. The best way to do it is to set the air starting valve to open after the piston has passed dead center. This will save a lot of air, since the piston will be moving outward when the air strikes it on the second turn. To prevent too much leakage about the piston a pint of lubricating oil can be poured in on the top of each piston. The oil will effectually seal the clearance and will raise the compression pressure high enough to ignite the fuel when the fuel valve opens. There is no danger of the lubricating oil pre-igniting. The engine, even though badly worn, will usually fire.

There are extreme cases of engine wear where even the method outlined above fails to scure results. It is possible to block open the admission valves of the firing cylinders until a fairly high angular velocity is attained. Throwing the admission valve into place at this time will invariably secure regular firing. Of course the proper relief is the reboring of the cylinder and the installation of new pistons. Above all else, no Diesel engine should be dosed with gasoline or kerosene.

*Presented before Columbian Gasoline Corporation foremen's meeting.



DISTILLATION EQUIPMENT

Bubble Decks, Bubble Towers, Tube Still Heaters, Topping Stills, Reducing Stills, Rerun Stills, Vacuum Stills, Cracking Stills

Atmospheric and Vacuum Crude Oil Units

Combined Skimming and Cracking Units

Combined Pressure and "Vapor Phase" Cracking Units

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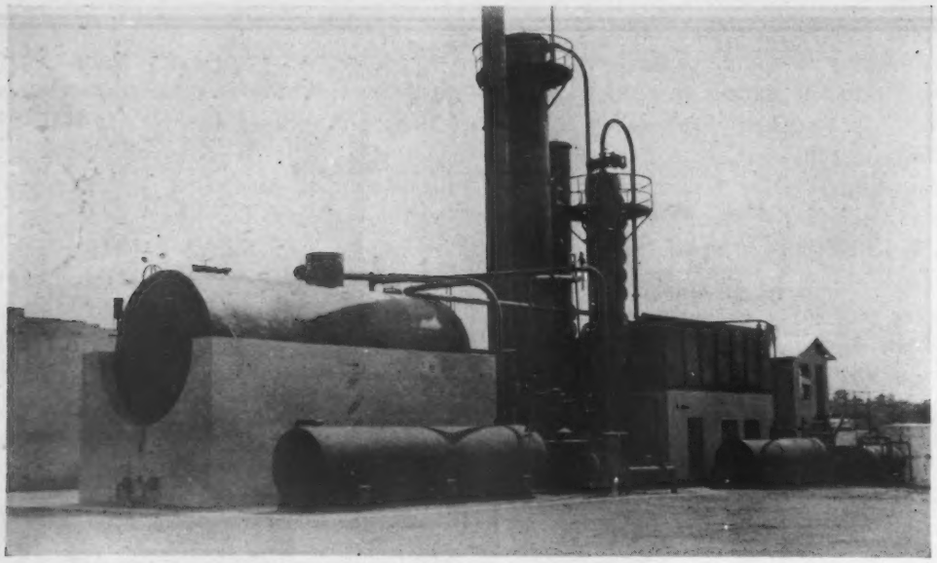


This shell still of 750 barrels capacity, is running 2500 barrels daily continuously through the use of modern auxiliary equipment. Producers Oil Company, Bristow, Oklahoma

Shell Still and Towers Replace Battery

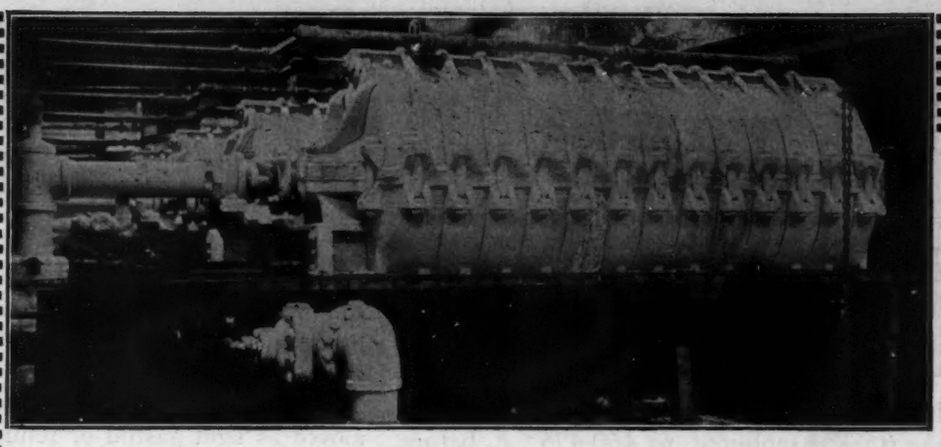
PRODUCERS Oil Company at Bristow, Oklahoma, for the past year has been operating a new single shell still and fractionating column unit which has replaced a former complete battery of stills. The design includes a waste heat retort, or economizer, under the stack, the utilization of efficient exchanger equipment, and multiple bubble type fractionating columns, and by means of these modern auxiliaries the single shell still is enabled to process 2500 to 3000 barrels of crude daily.

Through the judicious use of salvagable material in stock on the refinery yard and by affecting economies wherever possible the completed unit was erected at a cost of about $40,000. With the exception of the Tulsa type fractionation or bubble columns and Sterling sectional condenser equipment, practically all of the materails, such as brick, piping, fittings, steel plate, and the like, were appropriated from the old plant which was abandoned. The unit was constructed under the supervision of C. H. Fox, who has been in charge of the company's refineries for the past three years.

Crude, which is produced locally, flows by gravity from hill-top storage to the plant, passing in split streams through a Cloverleaf coil mounted in the upper part of the main fractionating column, with another portion of the cold oil passing through a Tulsa type exchanger mounted on top of the exchanger or flash tower. These streams are then combined and pass through an exchanger placed on the gas oil run-down line leading from the bottom of a tower to the receiving house. In this exchange the crude is heated to about 180°F. and at this temperature it passes into the baffled water separator where the water settles out and is withdrawn.

The oil flow then continues through the fuel oil or residue heat exchanger where temperature is increased to 325°F. by exchange with the hot residuum. At this preheat temperature the oil enters a flash tower where a stream of export grade of gasoline is removed overhead, constituting about 15 per cent of the crude charged. The exchanger tower (so-called because it fractionates a stream evaporated by the exchanger system) is 45 inches in diameter and 33 feet high, containing six bubble cap trays and reflux control at the top. The oil enters the tower at a point seven feet above the base and flows downward over the stripper sections, to accumulate in the bottom of the column from which point it is continuously withdrawn into the b.s. separator—size seven by 18 feet. In this settling all of the foreign matter in the crude is removed, which permits the plant proper to remain on stream for longer intervals. The separator, placed horizontal on the ground near the shell still, is heavily insulated to maintain temperature as near as possible to the 325°F. of preheat. The tank is equipped with a visible level indicator which was designed by Mr. Fox, and which was discussed in detail in a previous article.

Oil from the separator is pumped into the still



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Entirely Closed Operation. Vallez Filters operate in a completely closed circuit. Losses by vaporization are negligible; fire hazards are reduced to a minimum; operating conditions are greatly improved by elimination of fumes and dust.

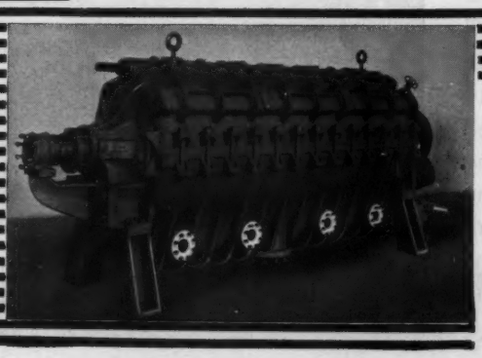
Less Retained Oil in Press Cake. Uniform, homogeneous cake formation is obtained in the Vallez Filter—which means highest filtration rates, clearer filtrates and highest cake washing efficiencies.

Drier Cake Discharge. The Vallez self-draining leaf empties all the space back of the filter cloth every revolution. A perfectly dry cake can be obtained—and steaming or blowing time is reduced to an absolute minimum.

Picture what the above facts about Vallez Filter performance mean in your development program. Those expensive solvents—so efficient in the laboratory—can now be economically used in plant scale production and used with perfect safety. (The installation pictured here is doing this very thing.)

The Vallez Filter will improve your plant's efficiency in many ways and will pay for itself in a very short time. Write for further information and let our engineers help you with your filtration problems.

VALLEZ *Rotating Leaf* FILTER



Write for Filtration Bulletin 4a

GOSLIN-BIRMINGHAM MANUFACTURING CO., Inc.

Vallez Filter Division: 15675 Lathrop Ave., Harvey, Ill.
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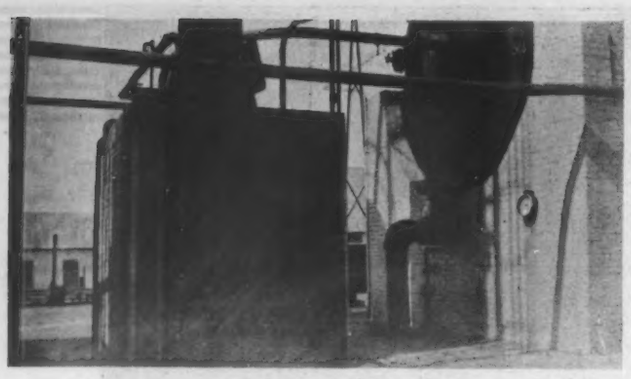
Works: Birmingham, Alabama
New York Office, 82 Beaver Street

Address Inquiries to Harvey, Illinois



Crude is preheated in the economizer upon which the smoke stack is mounted, to 460-475° F. before entering the still, thus utilizing hot gases of combustion

through the economizer placed under the stack. This coil consists of 40 tubes, eight feet long and of three-inch diameter connected with welded U bends. The coil is heated by flue gases coming from the shell still furnace to the stack. The coil or economizer is supported on a concrete base which supports eight six-inch channel irons, two at each corner. These are connected at the top by 10-inch channel irons. Four I-beams are placed on the roof to form a rectangle for the support of the stack, which is centrally located on the roof of the economizer. Hot gases of combustion from the shell still heat the crude to 460-475°F. at this point.

The oil then enters the shell still, which is of conventional type having a capacity of 750 barrels and is 12 feet by 30 feet in dimensions. Liquid level in the still is automatically maintained at approximately half of the still capacity. A visible indicator is installed as a means of checking the automatic control.

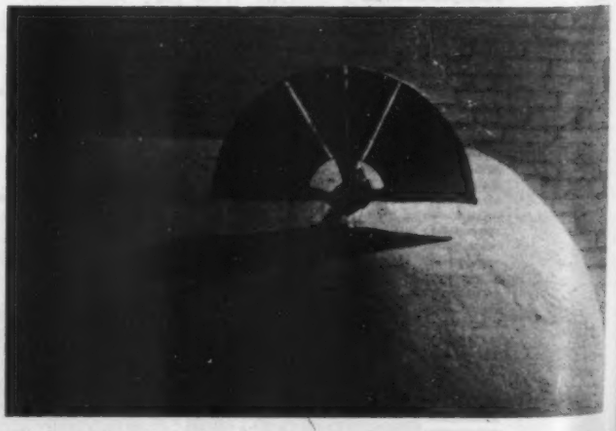
Still temperature is maintained between 500° and 510°F. with vapors passing to the primary fractionating column as in customary practice. The bottoms, however, are continuously drawn off by means of a pump which circulates a portion of the back into the still, and permits the major part of the oil to pass through exchangers, coolers and to storage.

The volume of oil returned to the still is governed by a liquid level control device, especially designed for the work. An electrically driven Worthington centrifugal pump circulates the residual oil either to the storage system or through a system of coils placed inside of the still which are perforated to distribute the oil streams at many points along the bottom of the still. This system is said to increase the turbulence and quicken the heat transfer between the oil and the shell still wall or bottom and to eliminate local overheating or hot spots. It permits longer periods on stream. Practice at the plant calls for a shut down period every 90 days for cleaning and a general inspection of the apparatus. The still, however, has always been found very clean.

Vapors derived from heating the oil pass into a fractionating column 51½ feet high and five feet in diameter. The column is provided with 11 rectifying bubble trays and four stripper sections or trays. And the overhead fraction is removed which condenses to 54-56 U. S. motor gasoline. A side stream is removed from any one of six points at the side of the fractionating column which enters an auxiliary column, three feet in diameter and 20 feet in height. This tower is equipped with 10 bubble trays for fractionating the naphtha and gas oil. A naphtha stream is removed overhead running 46-48 gravity and 450 end point. The reflux or bottoms in this small tower are either removed as light gas oil or returned to the shell still as reflux. The arrangement for removing a side stream from any one of six points at the side of the main tower contributes much to the flexibility of operation and provides for the preparation of a wide range of naphthas without additional equipment.

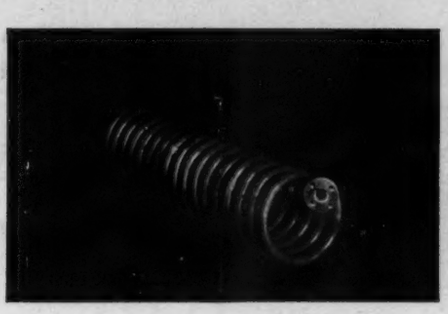
The water system consists of a deep water well, a large reservoir and a cooling tower. The cooling water first passes over the gasoline vapor condenser and then flows by gravity over the condenser used for cooling the heavier tower-bottom streams such as stove distillate and gas oil. These are removed from the bottom of the auxiliary tower, and the bottom of the main tower, which stream is a gas oil. The water is therefore first used to condense two streams of gasoline, a naphtha stream, a heavy distillate stream, gas oil stream, and fuel oil. It then flows by gravity to the reservoir, with surplus overflowing into a nearby creek.

A later addition to the refinery equipment consists of a continuous treating plant for sweetening the gasoline fractions when necessary. The treating unit consists of one wash drum and two settling drums. The gasoline is pumped through sodium hypochlorite solution, wich is all the treatment required. The finished sodium hypochlorite solution is held in an underground container, transferred to a lower blow case by gravity and then transferred to the washing drum by air pressure instead of pumping.



Visible oil level indicator used on separator and still for checking automatic control devices, designed by the plant manager

no coil is too small ...and no bend is too large



YOU may need only a small pipe coil—or perhaps you require a quantity of large bends for high pressure service. But in either case (and irrespective of your location) you are assured a first-class job that is quickly, accurately and economically done if you place your order with Midwest.

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Midwest also frequently supplies all the fabricated piping for a large power plant—or a complete refinery—or an industrial process. The advantages of using "The Greater Midwest Piping Service" are constantly becoming more obvious.

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THE GREATER MIDWEST PIPING SERVICE

昭和 年 月 日

DAILY REPORT
FOSTER DISTILLATION PLANT

下.

ATOMS. TOWER. CRUDE G.R. BARRELS PER DAY

TIME 時間	OIL 油 TEMP 温度 IN 入口	OIL 油 TEMP 温度 OUT 出口	OIL 油 PRESS 圧力 IN 入口	OIL 油 PRESS 圧力 OUT 出口	STEAM蒸気 IN 入口	STEAM蒸気 OUT 出口	TURNS OF STEAM VALVE 蒸気バルヴ開キ NAPH 重油	KERO SENE 灯油	GAS OIL 軽油	BOT TOM 底部	GASOLINE 軽揮 TOP TEMP 頂部温度	GR 比重	NAPHTHA 重揮 BOX SET'G 箱レ量	TEMP 温度	GR 比重	KEROSENE 灯油 BOX SET'D 箱ト量	TEMP 温度	GR 比重	FLA SH 引火点	GAS OIL 軽油 BOX SET'G 箱レ量	TEMP 温度	GR 比重	FLA SH 引火点	BOTTOMS ボトム TEMP 温度	GR 比重	FLA SH 引火点	V100	CHARGE PUMP PRESS 揚込ポムプ圧力	WATER CONTENT INCRUDE 原油含水分
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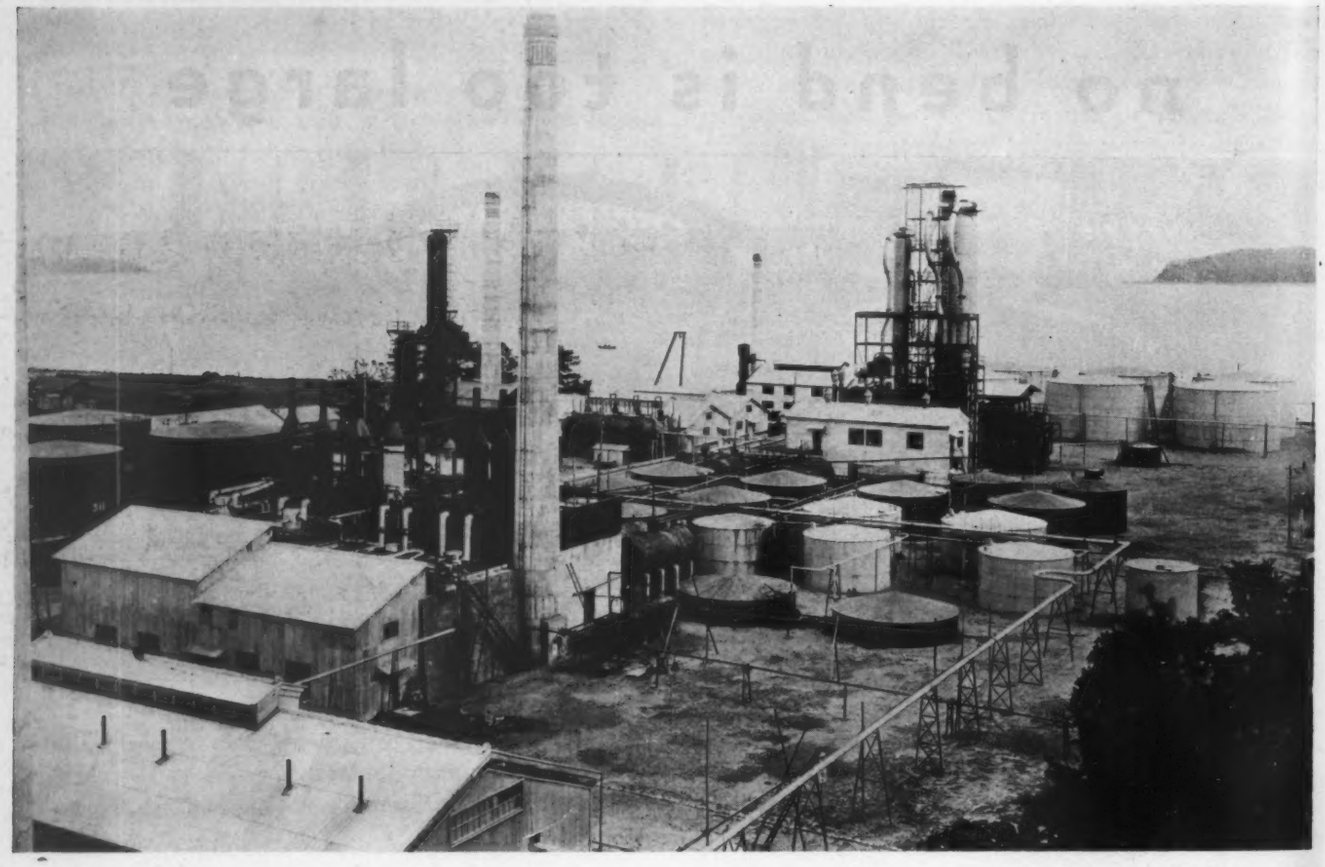

General view of Nippon Oil Company, Ltd., refinery at Kudamatsu, Yamacuchi Ken, Japan, where late modern equipment has recently been installed. The old battery in the left foreground is now used as a re-run unit. In the left background is shown the Cross cracking units. Center background is the acid recovery plant. In the right background is the new two-stage combination atmospheric-vacuum distillation unit of Foster-Wheeler type recently completed and placed in operation. Above and below are shown portions of the two run sheet forms with their Japanese characters on which stillmen report operation of the new distillation equipment.

昭和 年 月 日

DAILY REPORT
FOSTER DISTILLATION PLANT

下

VAC. TOWER. CRUDE G.R. BARRELS PER DAY

TIME 時間	OIL 油 TEMP 温度 IN 入口	OIL 油 TEMP 温度 OUT 出口	OIL 油 PRESS 圧力 IN 入口	OIL 油 PRESS 圧力 OUT 出口	STEAM蒸気 IN 入口	STEAM蒸気 OUT 出口	TURNS OF STEAM VALVE 蒸気バルヴ開キ SLOP WAX スロップワクス	SYL. STOCK シリンダーストク	BOT TOM 底部	GAS OIL 軽油 TOP TEMP 頂部温度	GR 比重	FLA SH 引火点	HOT WELL TEMP ホーラー温度	WAX DIST ブレス原 BOX SET'G 箱レ量	TEMP 温度	GR 比重	V30	SLOP WAX スロップワクス BOX SET'D 箱ト量	TEMP 温度	GR 比重	V50	GYL. STOCK シリンダーストク BOX SET'G 箱レ量	TEMP 温度	GR 比重	V100	BOTTOMS アスファルト TEMP 温度	PENE 針入度	MELT 溶融点	VAC; DEG REE 真空度	CHARGE PUMP PRESS 揚込ポムプ圧力
A.M 7午前																														
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10																														
11																														
12																														
P.M.																														

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Whatever your mixing or agitating process, we shall welcome opportunities to submit plans for reducing the time, labor, space and power elements or for improving the process to improve the product.

Our research laboratory is adequately equipped and manned for helpful study, our engineers are specialists in the design and use of all types of equipment for mixing liquids with other liquids, solids or gases.

We welcome opportunities to study requirements and submit recommendations

Petroleum bulletin gladly sent on request.

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3556-A

Chemical Industries Exposition

FOUR hundred and fifty or more exhibits will fill three spacious floors of Grande Central Palace, when the Thirteenth Exposition of Chemical Industries opens the week of May 4 to 9. These displays will illustrate scores of phases and ramifications of the vast industries that are dependent in their operations upon a chemical change in the nature of the material, or are under chemical control. Among the numerous layouts will be raw materials, chemicals, machinery, boiler room equipment, including refractories, gauges, automatic control and other precision instruments, and laboratory equipment, besides a list of equipment and supplies hardly to be classed under any of the foregoing heads. The following is a more elaborate partial classification:

Chemicals—Oils, greases, fats, fatty acids, lacquers, enamels. Industrial chemicals, carbons, pigments, alkalies, cement, high temperature plastics, rust proofing, refractories, laboratory chemicals, lime —chemical and hydrated—fire proofing compounds, various gases, resins, dyes, solvents, metal coatings, decolorizing and purifying materials, building materials.

Metals—Castings, iron, bronze, perforated metals, alloys, ferrous and non-ferrous steels, precious and semi-precious metals.

Machinery—Pumps, crushers, conical ball mills, grinding mills, pulverizers, condensers, chemical plant equipment, coolers, crystallizing equipment, dissolvers, lime kilns, drying machinery, vacuum rotary drums, pulverized coal equipment, evaporators, extractor plants, heating systems, accessories, industrial ovens, pharmaceutical machinery, vacuum stills, buckets elevator, dust collection systems, conveying machinery, couplings, filling machines, magnetic separators, mixing and kneading machinery, bottling machinery, clarifiers, filter cloth, strainers, screens, Rayon equipment machinery, masticators, hydraulic presses, clamshell buckets, labeling machinery, compressors, pipe fittings and blowers, spray nozzles, gears, speed reducers, nitrators, solvent recovery equipment, reactivating equipment, autoclaves, caustic pots, colloid mills.

Instruments of Precision and Laboratory Equipment—Balances, scales, laboratory apparatus, testing instruments, laboratory sinks, hopper scales, stone flooring, laboratory furniture, acid proof sinks, acid proof stoneware, crucibles, pyrometers, tubes, towers, silica ware, automatic temperature control, gages, meters, recording instruments, regulators for pressure and temperature, tachometers, thermometers, ature controller, centrifugals, optical instruments, microscopes, colorimeters, hydrometers, respirators, glass pipe, electric ovens, chromium plating temperporcelain ware, furnace accessories.

Containers—Barrels, drums, cylinders, for high pressure gases, metal containers, seamless tanks, bags (burlap, cotton, paper, mailing) linen containers for bags, barrels, kegs, packaging equipment, water-proof papers, paper lined burlap, cotton, shipping labels, glass lined tanks, stills, sterilizers, monel tanks, cans, fibre drums, metal lined drums, insulated containers, bottle caps, metal caps, cooperage.

Materials Handling Equipment—Automatic bagging scales, industrial chemical scales, coal scales, automatic, convey-o-weigh for ground and crushed materials, gas producer scales, liquid scales, automatic proportionary scales.

Rubber and Hard Rubber Products—Acid resisting materials, barrels, drums, battery parts, chemical plant equipment, food industry equipment, insulating materials, pipe fittings, plastics, pumps, tanks, rubber products equipment, valves and fittings, baskets, rubber lined tanks and cars, conveying machinery, flooring, transmission equipment, belts.

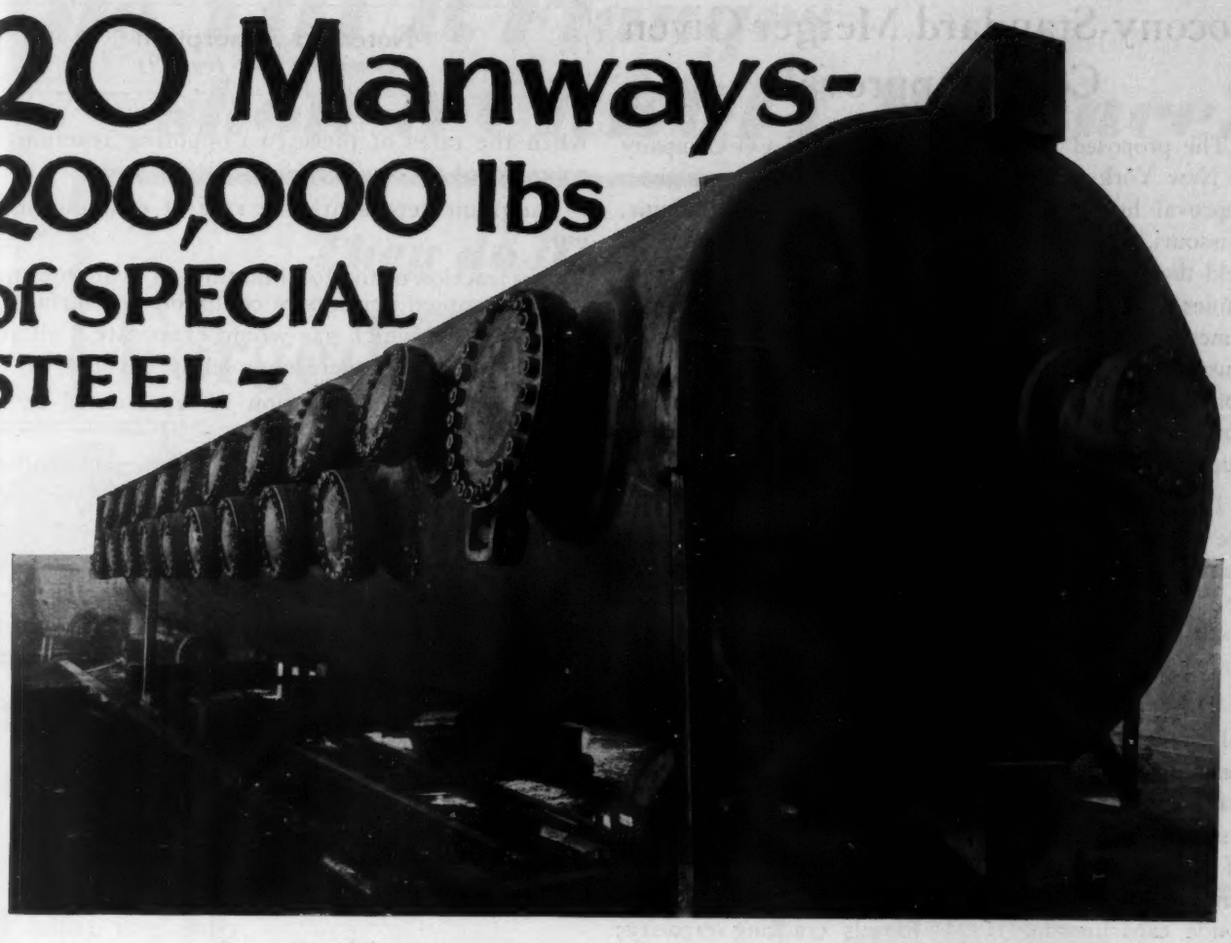
In the coming exposition gauges and automatic control instruments will be an important feature. Many new instruments in this field will be shown. There will be, for example, a manometer, used with an electric flow meter, for measuring the flow of gases where pressures do not exceed 50 pounds per square inch with differentials as low as 2.53 inches of water. Alongside this instrument will be one designed for 500 pounds per square inch.

A pressure gauge designed to record its measurements at points remote from the gauging station, to be shown along with the foregoing instruments, operates by means of a tubular helix which opens and closes with pressure changes. This motion causes an armature to rise and fall in an inductance bridge coil, thereby actuating an indicating or recording instrument in the shape of a similar coil armature at a distance. In fact, both armatures may act as indicating and recording instruments, the one being in the plant, the other in a distant office. Pressure changes may be accurately transmitted 30 miles.

In the same classification also comes the new instrument for indicating or recording, and transmitting to distant points, changes of level in a liquid. This instrument operates on the inductance bridge principle in conjunction with the remote indicating or recording meter. It is applicable to heavy viscous fluids with which the manometer type could not be used. Its action depends upon a float which rises or falls with the level of the fluid, thereby moving an armature within a transmitter coil. A duplicate armature in the receiving instrument causes a meter to indicate or record the changing level.

Pressure of gases and of liquids, voltage and amperage of electric currents, depth of fluids in tanks, towers and reservoirs, the flow of steam, of water or of chemicals, of petroleum products, of air and other gases—these and many other uses for automatic control, indication and recording, are met by old and new equipment to be exhibited at the coming exposition.

20 Manways- 200,000 lbs of SPECIAL STEEL-



HIGH POINTS OF THIS MASSIVE FLUID-FUSION WELDED FRACTIONATING TOWER

The equipment and skill required to fabricate such a vessel as this 9′ x 53′ welded fractionating tower with its 20 manways and numerous nozzles is hard to appreciate.

In the first place the simple forming and handling of such enormous tonnage is beyond the equipment of the average shop. Before such fabrication ordinary welding methods are futile. The many manways and nozzles present a strain and contraction problem that would soon bring grief to the inexperienced fabricator.

But to P. I. W. with its Fluid-Fusion welding, complete equipment and wide experience, such vessels are routine production requiring little more supervision than smaller and less complex equipment.

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Socony-Standard Merger Given Court Approval

The proposed merger of the Standard Oil Company of New York and the Vacuum Oil Company was given approval by three federal court judges at St. Louis, Missouri, February 7. The Circuit Court of Appeals held that there is no intention on the part of the companies to form a combination in restraint of trade, that a merger would not be in violation of the Sherman anti-trust law, and that it would not dominate or approach domination of the industry. It was announced that the government would appeal the case to the United States Supreme Court.

In their decision of February 7 the judges held that the merger results would be "more rapid expansion at home and abroad" and that the merged concern would be "third or fourth in financial strength in this country sixth in crude oil production and fourth or fifth in refining capacity."

The Standard Oil Company of New York in domestic oil circles is now listed as fourth in refining capacity, since through its subsidiaries it has a total of 15 refineries aggregating 245,000 barrels crude oil capacity daily, and 93,000 barrels cracking capacity with a total of 58 cracking units. The organization consists of the parent company with three refineries, 34,000 barrels crude capacity and 16,000 barrels cracking capacity; the Magnolia Petroleum Company with five refineries rated at 85,000 barrels capacity, 22 cracking units of 62,000 barrels capacity; the General Petroleum Corporation with four refineries of 105,000 barrels total capacity and no operating cracking units. Recently White Eagle Oil Corporation was acquired with its three plants totaling 21,000 barrels capacity, and with 27 cracking units of 12,000 barrels daily capacity. This lineup gives the Standard Oil Company of New York refining and marketing facilities throughout the East Coast, Texas-Louisiana, Mid-Continent, and West Coast areas.

Vacuum Oil Company has long been a leader in production and marketing of lubricating oils and during the past two years it has been rapidly expanding its marketing facilities through purchase of a larger number of marketing companies and some refining organizations. Vacuum Oil Company's refining facilities consist of two plants in New York State with a total of 26,500 barrels capacity, and 8300 barrels cracking capacity through the use of nine cracking units. With its subsidiaries the company has a total of six plants, 44,000 barrels crude capacity, 22,100 barrels cracking capacity and 20 cracking units. The subsidiaries consist of Lubrite Refining Company with its plant at East St. Louis, The White Star Refining Company, with two plants, and the Bartles-Maguire Company (recently acquired through the purchase of Wadhams Oil Corporation) with its refinery at East Chicago.

Notes on Adsorption

(*Continued from page 79*)

when the rates of these two opposing reactions become equal an equilibrium is established.

Langmuir represents the rate of evaporation by: $v\,\theta$

θ = fraction of the total number of available spaces occupied per square centimeter of surface.

v = rate at which gas would evaporate if all available spaces were completely covered.

The rate of condensation is represented by: $a\,u\,(1-\theta)$

a = fraction of total number of colliding molecules (u) that adhere to surface.

$(1-\theta)$ = fraction of total number of spaces that is unoccupied.

At equilibrium these rates are equal and so the expressions may be equated thus forming an equation for the adsorption at equilibrium.

Rate of evaporation = rate of condensation.

$$v\,\theta = a\,u\,(1-\theta)$$

$$\text{So: } -\theta = \frac{a\,u}{v + a\,u}$$

$$\text{Let } \frac{a}{v} = B,$$

$$\text{Then } \theta = \frac{B\,u}{1 + B\,u}$$

The number of molecules colliding per square centimeter (u) is proportional to the gas pressure, P. For B u we can write k_1 P by combining the proportionality factor and the factor B and calling the result k_1. Since θ is proportional to the number of adsorbed molecules u we can substitute u for θ and combine the new proportionality factor with k_1 in the numerator, thus obtaining another constant k_2.

$$\text{So: } u = \frac{k_2 P}{1 + k_1 P}$$

This equation gives the relation between the amount of gas adsorbed (u) and the equilibrium pressure P.

For very low pressures k_1 P in the denominator becomes negligible compared with unity, so then: $u = k_2 P$. This corresponds to the initial steep slope of the adsorption isotherm.

For very high pressures k_1 P becomes very large compared with unity, so then: $u = \frac{k_2}{k_1} = \text{constant}$. This corresponds with the practically horizontal portion of the curve for the adsorption isotherm at high pressures.

Polanyi, Illiin, and others have continued the investigation of the kinetics of adsorption begun by Langmuir.

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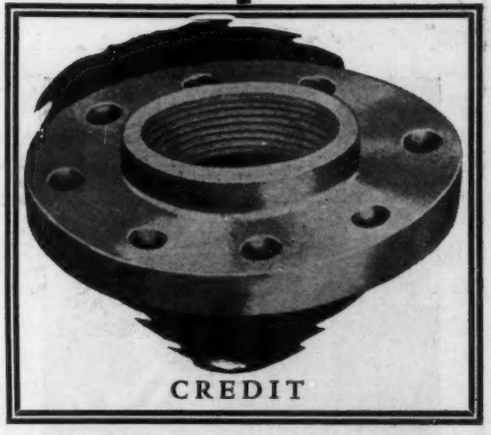
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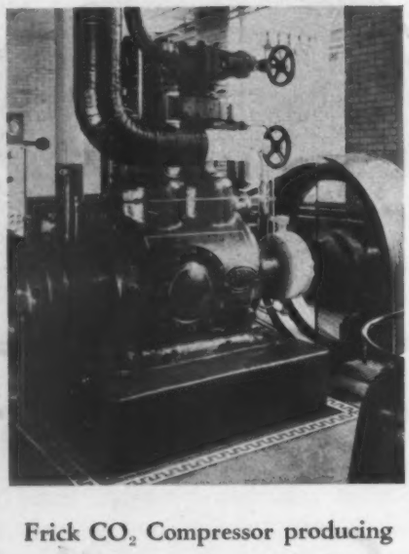

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PLANT MEN AND METHODS

By GEORGE REID

New Petroleum Dictionary Published The "Petroleum Dictionary" by Hollis P. Porter, consulting engineer, Tulsa, and now ready for distribution, is a very thorough and comprehensive glossary of terms used in the producing, refining and marketing branches of the petroleum industry. There has been a long recognized need for such a work, and this need has increased during recent years because of the introduction into the language of the industry of very many new words and expressions used in the discription of recently developed processes and appliances. The "Petroleum Dictionary" of 234 pages presents over 3000 terms and definitions. The work is offered those engaged in the petroleum industry as a first edition, the author having in mind the compilation and publication of future editions when the need arises. This book may be secured from the Gulf Publishing Company, Houston, Texas, Price $3.00.

W.P.R.A. Preparing Interesting Program Several interesting and valuable papers are being scheduled by the program committee arranging for the annual convention of the Western Petroleum Refiners Association, to be held at the Elms Hotel, Excelsior Springs, Missouri, March 10 to 12. The first day will be given over to executive and business sessions at which time officers for the coming year will be elected.

Among those papers already promised, one dealing with "Vacuum Distillation of Pressure Distillate" by John Primrose, Foster-Wheeler Corporation, is most timely. S. S. Smith of Shell Petroleum Corporation, Tulsa, will discuss the new natural gasoline specifications. A paper discussing the "Manufacture of Grease" will be presented by F. N. Simpson and C. C. Welch, Empire Oil & Gas Company. "New Developments in Refinery Gas Recovery Systems" is the subject of a paper being prepared by A. W. Burkett, Jackson Engineering Corporation. F. C. Koch, Winkler-Koch Engineering Company will discuss his experience in Russia while supervising the installation of refineries in that country. It is planned that a representative of Sinclair Refining Company, from the Wellsville, New York, plant will discuss the manufacture of bright stock. "What Constitutes a Good Fuel and Lubricant from an Automotive Engineers Standpoint," is the subject of a paper to be prepared by H. C. Mougey, General Motors Research Laboratories.

Distillation of East Texas Crude The newest oil producing territory in Texas promises to become one of the largest the state has ever witnessed with the development switching from West Texas to East Texas—in and around Rusk County, in what is termed the Joiner field. The crude from three completed wells, which indicate a probable producing area some 23 miles long, is sweet, runs 36 to 40 A. P. I. gravity, low in sulphur, and by Hempel distillation yields 33 to 37 per cent gasoline, 10 to 15 per cent kerosene, and a large yield of gas oil, which like the remaining fuel oil residue lends itself well to processing in the cracking unit. The crude is dark green in color and has a sweet odor. Products of distillation are low in sulphur and those which need chemical treatment respond well to the sodium plumbite or the hypochlorite treating proceedure.

New Head of Vacuum Research Laboratories Dr. Harry A. Curtis, chairman of the division of chemistry and chemical technology of the National Research Council, has been appointed chief of the research laboratories of Vacuum Oil Company. He is well known among oil men and chemists of this country as he has been active in many lines of chemical engineering activity.

The nitrogen survey made in 1923 for the United States Department of Commerce won Dr. Curtis wide recognition. During the same year he became professor of chemical engineering at Yale University. He was appointed in 1926 by President Coolidge as a member of the Muscle Shoals inquiry board. He has, for several years, been consultant for a number of organizations of national importance.

New Pasotex Manager in Charge C. E. Finney, Jr., formerly with the Standard Oil Company of California, has taken over the managership of Pastex Refining Company, El Paso, Texas. He was selected to fill the position made vacant by the recent deal of W. G. Hamilton, former manager at El Paso. Mr. Finney is a native of Kansas City, Missouri, is a graduate of the school of mechanical engineering, Cornell University, and has received his practical training with American Smelter and Refining Company, and Standard Oil Company of California. He worked with the late W. G. Hamilton in the construction of the Pasotex refinery about two years ago.

Weekly Reports of Cracked Gasoline Reports showing production of cracked gasoline in the United States are being made weekly by the American Petroleum Institute in connection with the organization's established reports covering crude oil production, gasoline stocks, crude runs to stills, and the like. Cracked gasoline production figures are given by refining districts, and companies owning 86 per cent of the country's charging capacity are reporting to the Institute. The Institute plans to begin publication of weekly reports showing stocks of gasoline at bulk terminals and in transit. Collection of these data by the department of statistics has been authorized by the board of directors. The new report will enlarge the picture of gasoline stocks now provided by weekly reports covering stocks at refineries.

Measuring, Sampling and Testing Crude Oil The "American Petroleum Institute Code Number 25 for Measuring, Sampling and Testing Crude Oil (Tentative)," has been published in a second edition, dated January, 1931, and now is available for distribution. The new edition is a revision of the September, 1930, proof copy and contains changes adopted at the eleventh annual meeting of the Institute at Chicago last November as summarized in the report of the Institute's division of production central committee on measuring, sampling and testing crude oil.

The objective of the tentative code is a unification of the wide variety of methods and practices employed in measuring, sampling and testing crude oil. In instances where it has been impossible to obtain national agreement upon a single method, exceptions have been noted and in some cases alternative methods described.

Companies representative of all sections of the country cooperated in the preparation of the code, it is hoped it generally will be used as a basis for company procedure and of assistance in promoting uniformity in methods and practices involved in handling crude oil.

The book, a publication of 40 pages, covers tank measurement and calibration, gaging, sampling and testing crude oil, general and marine; suggested forms for numbering tanks and for gage tables; tentative method of test for gravity of petroleum and petroleum products by means of the hydrometer, and standard methods of test for water and sediment in petroleum products by means of centrifuge. Copies of the code may be obtained for 50 cents each, with discounts for quantity purchases, from the American Petroleum Institute, 250 Park Avenue, New York City.

Interesting Power Conference Papers The Fifth Midwest Power Engineering Conference and the Fourth National Fuels Meeting of the American Society of Engineers are held in Chicago February 10-13 at the Coliseum. Several papers are included in the tentative program, which are of interest to the refining industry. Among these are the following: "Dual Purpose Plants and Commercial Distribution of High Pressure Steam", by John M. Darbelle, February 10; "Power Requirements for Pumping of Oil, Gas, and Gasoline" by A. E. Harnsberger, February 11; "Use of Refinery Waste Fuels in Modern Steam Plants", H. J. Klotz, February 11; and "Developments in Pulverized Fuel Firing", by H. Kreisinger, February 12.

Inventor of Refining Processes Dies Milon J. Trumble, aged 52 years, well known in refining circles of the United States as the inventor of the Trumble refining process and the Trumble cracking process, died in Los Angeles January 16, with interment January 21, the services being attended by relatives, business associates and many friends. He is survived by his wife, two sons and one daughter. Mr. Trumble was a partner in Trumble Gas Trap Company and one of the organizers of Trumble Refining Company, which operated in California for some years. He was born in Michigan and came to California 28 years ago. Mr. Trumble some years ago spent many months in experimenting with a process for extracting oil from shale, and during his lifetime was well known as an inventor and was constantly experimenting along petroleum lines.

Reduce Treating Costs By Fractionation Proper fractionation of the gasoline yield of a pressure distillate will with most distillates, decrease the amount of chemical treatment that will be required by the gasoline to meet trade requirements, is the conclusion reached by engineers of the United States Bureau of Mines, Department of Commerce, based upon a detailed study of refining of light petroleum distillates. The results of the work are reported in Bulletin 333, "Refining of Light Petroleum Distillates," by H. P. Rue and Ralph H. Espach. The treatment of the subject logically developed into two closely related parts; one, the principal methods of refining light petroleum distillates, the equipment used, and the effects of the different refining agents; and two, a study of the value of fractionation as an aid in the refining of pressure distillates.

Copies of Bureau of Mines Bulletin 333, "Refining of Light Petroleum Distillates," are obtainable from the Superintendent of Documents, Government Printing Office, Washington, D. C., price 25 cents.

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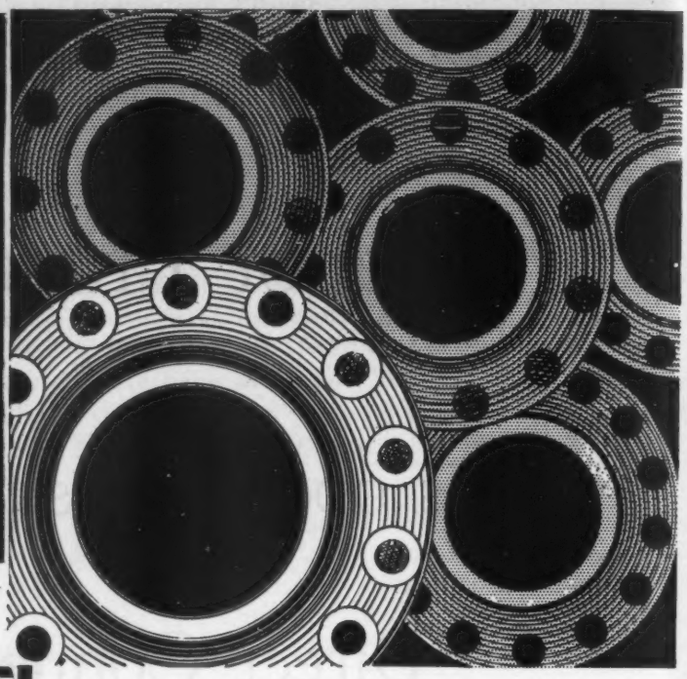

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REFINERY AND GASOLINE PLANT ACTIVITIES

New Plants – Construction Notes – Personnel Changes

Continued Activity in Refinery Construction

CONSTRUCTION of crude oil topping plants in and near the prolific high gravity oil fields uncovered late in 1930 and early in 1931 in Rusk and Gregg Counties, East Texas district, promises to materially swell the refining capacity of Texas. While a large number of separate plants are contemplated for early erection by independents, construction work is underway on two projects.

East Texas Refining Company was the first to locate in the area, having started work middle January on a 3000-barrel skimming plant about three miles northeast of the Joiner field, Rusk County, with provisions made to double the capacity later. Freeman W. Burford, president Burford Oil Company, which has a refinery in operation at Pecos, Texas, is head of the above refining concern, and J. J. Thomas is vice-president and superintendent. Offices have been established at Henderson, Texas. The company has contracted for 1,000,000 barrels crude to be delivered by Rusk County Pipe Line Company, an affiliated concern, while a fuel oil contract has been made with the I&GN Railroad.

Beacon Oil & Refining Company has broken ground for the erection of a 2000-barrel plant to be located southeast of the Joiner field, and several miles northwest of Henderson. A four-inch line will be built from this refinery site to the Joiner field to run oil produced by Roy I. Carter et al. Carter, H. W. Roberts and others from Wichita Falls are sponsoring this project.

Construction of a 5000-barrel capacity plant at Tyler, Texas, with a six-inch line connecting with the Rusk County area, is planned by G. L. Rowsey, Taylor, Texas, E. L. Chapman, Fort Worth promoter, and the Taylor Refining Company. The latter is operating a skimming plant at Taylor, and is to subscribe to 51 per cent of the stock of the company to be formed in connection with the building and operation of the Tyler project. A one-year contract for the sale of fuel oil to the Cotton Belt Railroad has been promised.

J. T. Gillen, who has been identified with a refinery near Houston, is reported to be negotiating for crude contracts in order to carry out plans for the erection of a 2000-barrel refinery in Rusk County.

In addition to this local consumption of East Texas crudes, contracts have been made to deliver oil by tank cars to refining centers such as Shreveport, Dallas, Houston, and Camden, Arkansas, while large shipments are scheduled to be made by rail and tankers to the Warners, New Jersey, refinery of the Warner-Quinlan Company. Negotiations are pending for the movement in tank cars of large quantities of the comparatively low priced sweet crude to midwestern refineries.

Additional plant building continues in other refining districts. At Houston, Texas, American Petroleum Company will complete construction of a 2000-barrel skimming plant this month. In south Arkansas, Dayson Petroleum Company has started construction of its 300-barrel plant on a site between El-Dorado and Smackover.

Techna Oil & Refining Company has been organized to start operating a refinery completed last November on East 29 street, Long Beach, California. A new Kentucky refinery is under construction by Simrall Refining Corporation, which will be located at Horse Cave. Capacity reported at 1000 barrels per day.

Former officials of the old Paragon Refining Company, recently acquired by Gulf Oil Corporation have organized a new Paragon Refining Company and plan to build or acquire a small refinery.

Reports state that the Soviet Government has given approval to the Combine of All-Russian Oil & Gas Industries (Soyusneft) for an extensive program of building and expansion. The Asneft Oil Trust, the Grosneft Oil Trust, and the Sakhalineft plan enlargement of their existing plants and the erection of new refineries. Asneft will add about 135,000 barrels crude oil refining capacity, and about the same cracking capacity, according to reports, and Grosneft will add around 90,000 barrels crude capacity and 100,000 barrels cracking capacity, in new refineries, and in addition will enlarge wax and lubricating oil manufacturing facilities. Russia plans to double its present refining capacity in the next two years.

Cities Service Company is endeavoring to secure control of Richfield Oil Companies, now in receivership, through acquisition of stock. Indian Refining Company has been acquired by The Texas Corporation and new directors and executives elected to handle the company's affairs. Other acquisitions reported recently include purchase of Lewiston Oil & Refining Company by Continental Oil Company, and the sale of Tonkawa Petroleum Corporation's Tonkawa, Oklahoma, refinery to Morgan Petroleum Company.

Six units of the Hydrogenation process are scheduled for completion during the first half of the year. Two units at the Bayway, New Jersey, plant of

REFINERY AND GASOLINE PLANT ACTIVITIES

Standard Oil Company of New Jersey are now in operation. Standard Oil Company of Louisiana, and Humble Oil & Refining Company at Baytown, Texas, are building two units each. Each unit is rated at 2500 barrels daily capacity. Lubrite Refining Company, at its East St. Louis plant, has completed construction of two new 1500-barrel Pratt vapor phase cracking units. Rio Grande Oil Company announces that it will add 5000 barrels cracking capacity immediately.

Houston Refinery Building

American Petroleum Company, Houston, will complete construction work in February on a 2000-barrel capacity skimming plant, located on the Houston, Texas, ship channel, near Norsworthy station. Crude supply for this plant will be mostly obtained from properties of Republic Production Company, an affiliated concern in the West Texas and Gulf Coast fields.

Shut Down Canadian Plant

Associated Refineries, Ltd., has shut down its refinery in the Wainright field, Western Canada, for three months pending the sale of products in storage. The plant has a rated capacity of 500 barrels per day. Plans are under way for the addition of a cracking unit.

Century Plant Operating

Century Petroleum Company, Oklahoma City, has begun operation of its new refinery in the north end of the Oklahoma City field, securing crude production from the company's four producing wells nearby. An appeal of the company to the Oklahoma Corporation Commission for permission to produce sufficient crude to maintain continuous operation of the refinery, is under advisement.

Continental Buys Plant

Continental Oil Company has purchased the plant of Lewistown Oil & Refining Company, Lewistown, Montana, it was announced last week. This gives Continental a refinery of its own as an adjunct to its present production in the Cat Creek field.

Frank P. Book of Detroit, with his associates, organized Lewistown Oil & Refining Company in 1921. Since that time 13,000,000 gallons of gasoline, kerosene, and fuel oils have been manufactured at the plant annually. The crude comes entirely from the Cat Creek field. During the last 10 years this refinery has been one of Montana's largest shippers of gasoline. It has a daily charging capacity of 2100 barrels.

Cities Service Wants Richfield

Cities Service Company is seeking control of Richfield Oil Companies through purchase of stock in the latter companies on a proposed basis of one share of Cities Service for four shares of Richfield. The buying company, headed by Henry L. Doherty, announces that it already has a large block of Richfield stock, and that up to February 25 it will add to these holdings.

Richfield Oil Company is now operating under receivership. If finally acquired by the Doherty interests it will give the Cities Service Company its first representation on the West Coast, and will also place this company among the larger or major refiners of petroleum through the addition of Richfield's 129,000 barrels rated capacity.

Through the recent acquisition of Louisiana Oil Refining Corporation, Cities Service Company now has a total rated refining capacity of 96,600 barrels crude and 38,500 cracking capacity. Adding Richfield will bring Cities Service's total to 225,000 barrels crude, and 68,500 barrels cracking capacity, placing it in like importance as a crude oil refiner with The Texas Company, Gulf Refining Company, and Standard Oil Companies of California and New York.

Improve Refinery

Eason Oil Company, at its Enid, Oklahoma, refinery, is installing equipment for improvement of refining operations. The redistillation and reducing batteries are being enlarged and reconditioned, adding vapor heat exchangers, condensers, and bubble towers. A new gasoline recovery plant is being erected, which is of Braun type.

New East Texas Refinery

East Texas Refining Company has begun construction of a 3000-barrel daily capacity skimming plant near a group of tank car loading racks located to the northeast of the Joiner field, Rusk County, Texas. Freeman W. Burford, president of Burford Oil Company, is president of the new concern. Some of the equipment to be used in the new plant will be salvaged from an idle plant at Pyote, Texas. Contracts for crude supply has been made with Rusk County Pipe Line Company through its gathering system now under construction.

California Refinery Sold

Estado Petroleum Corporation has taken over the refinery of the Western States Refining Company, located on Hill Street, Long Beach, California, and will continue to operate. The new company is headed by W. R. Mack, Los Angeles, who has been interested in the refinery for some time through contracts for supply of crude.

Dayson Starts Construction

Dayson Petroleum Company, started construction of its new 300-barrel refinery late in January. The plant is located between El Dorado and Smackover, Arkansas. Smackover crude is to be processed for high anti-knock gasoline, kerosene, lubricants and asphalt with pipe still and fractionating system operating under vacuum. Sylvester Dayson, formerly with Lion Oil & Refining Company, is president of the company. (See Refiner and Natural Gasoline Manufacturer, December, 1930, page 156.)

Albany Plant Changes Name

Exchange Petroleum Corporation, which erected a small skimming plant at Albany, Texas, with rated capacity of 200 barrels per day (Refiner and Natural Gasoline Manufacturer, November, 1930, page 156), has changed the name of the company to Tulsa Refining Company.

Gillette Refinery Resumes

The Gillette Refinery, at Gillette, Wyoming, has been sold to D. B. Card and George E. Kiesling, operators in the Osage field, Weston County, Eastern Wyoming, who have changed the name to Gillette Refining Company, and will resume operations at the plant, running their own oil. John Selby of the Salt Creek field is to be local plant manager. The plant has a capacity of 180 barrels per day.

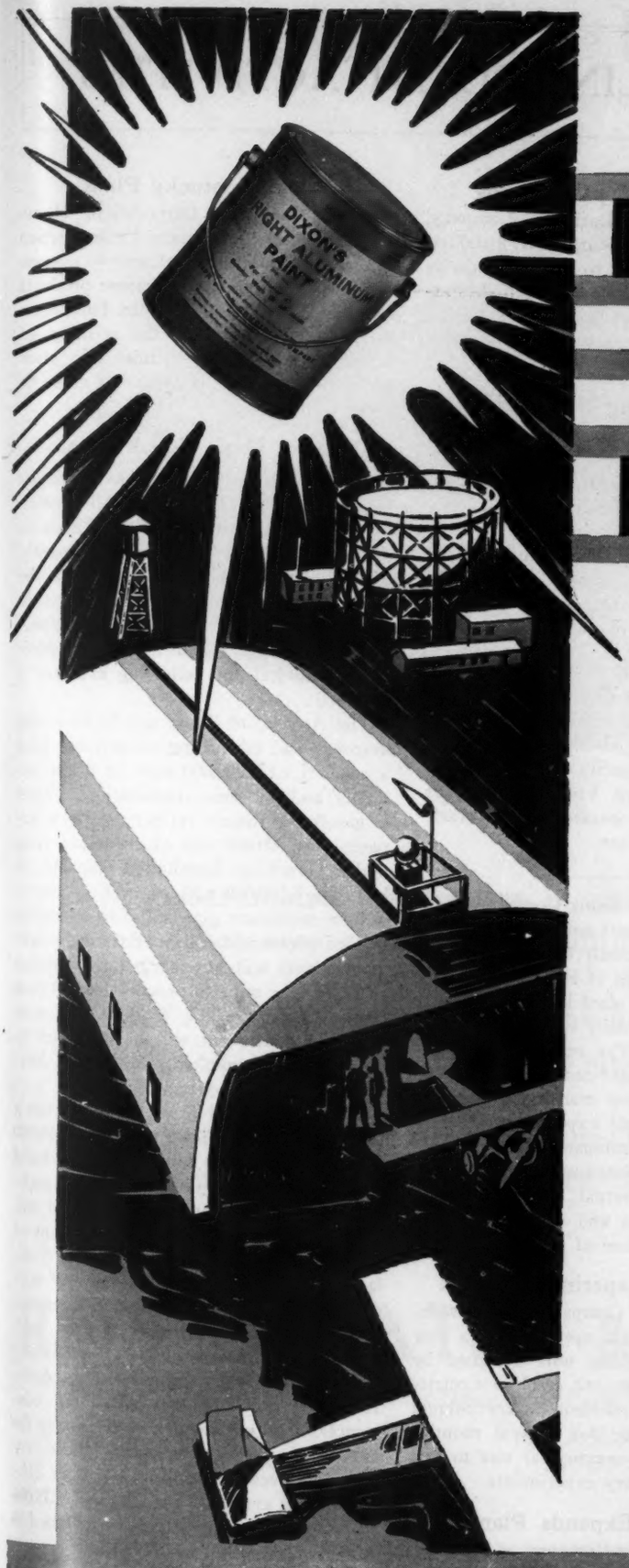
Complete Pratt Units

Lubrite Refining Company (Vacuum Oil Company subsidiary), at its East St. Louis, Illinois, refinery, has completed construction of its two new 1500-barrel Pratt vapor phase cracking units and test runs are now under way. The company abandoned its old Flemming units last November. Charging stock for the new units has been segregated and stored for the past few months.

Magnolia Expansion Completed

Magnolia Petroleum Company has completed its expansion program begun early last year, effecting an increase in crude oil capacity at its Beaumont, Texas, plant from 55,000 to 70,000 barrels per day. Additional cracking units bring the total to 20 Cross units with a rated capacity of 55,000 barrels per day.

The plant at Corsicana was increased in



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REFINERY AND GASOLINE PLANT ACTIVITIES

capacity from 1000 to 4000 barrels, the Luling plant was increased from 3000 to 5000 barrels daily capacity, and at this latter plant one of the new "controlled coil" cracking units was erected with a rated capacity of 3750 barrels per day. A similar cracking coil was installed at the plant of White Eagle Petroleum Corporation (acquired last year by Magnolia), having a daily capacity of 750 barrels.

E. E. Plumly, vice president of the company, is in charge of all refineries. H. H. Ziller, at Beaumont, is assistant manager; E. E. Swope, assistant manager; R. G. Sanders, is chief engineer and W. W. Leath, chief chemist.

Canadian Plant Resumes

Maple Leaf Refining Company, Coutts, Alberta, Canada, announces that it will resume operations at its refinery early in February. D. L. Hageman has been appointed to succeed F. K. Houston, retired, as manager of the company. Kevin-Sunburst and Red Coulee crudes will be processed.

Misko Plant Cracking Unit

Misko Refineries, Inc., Mirando, Texas, has completed the installation of a combination vapor and liquid phase cracking unit, of pipe still type. High benzol equivalent gasoline of 400 end point is being prepared from the Mirando crude. Emil Geppelt, consulting engineer, San Antonio, Texas, was in charge of construction.

Morgan Buys Tonkawa

Morgan Petroleum Company has purchased the refinery of Tonkawa Petroleum Corporation located at Tonkawa, Oklahoma. The acquiring company plans to recondition the refinery, which has been inoperative since June, 1930, and place it in operation early in February. The plant was erected in 1923 by the Constantin interests.

New Paragon Company

Paragon Refining Company, incorporated recently, has been organized to enter the refining and marketing of petroleum products with Rome E. Goodwin, formerly director and general sales manager of the old Paragon Refining Company, Toledo, Ohio, (recently acquired by Gulf Refining Company and dissolved). Negotiations are under way for a small refinery with which to start operations. Directors of the new company are R. E. Goodwin, president; A. K. Goodwin, William Boos, attorneys; Ira C. Taber and J. C. Daniels. The new company is located in Toledo.

Small Refinery Enlarging

Orange County Refining Company, Newport Beach, California, is installing a new distillation unit to increase capacity about one-third. The company makes asphalt, road oil, roof paints and similar products from the heavy crude production in the Newport field.

Peerless Being Reorganized

Peerless Oil & Refining Company, Chanute, Kansas, is being reorganized by Lloyd D. Burton and associates, who purchased the plant recently when the company was placed in receivership. (See Refiner and Natural Gasoline Manufacturer, Page 138, issue of January, 1931). The plant has a daily capacity of 2500 barrels, and was to resume operations February 1.

Rio Grande Expansion

Rio Grande Oil Company announced late in January that it would start immediate construction of 5000 barrels additional cracking capacity at its Los Angeles Basin refinery, Vinvale, California. The company now operates Jenkins cracking units at this point.

Rainbow Oil & Refining Company, Great Falls, Montana, plants and properties have been purchased recently by W. M. Fulton of Conrad, president of Fulton Petroleum Corporation. The plant is being enlarged and rebuilt for a daily charging capacity of 1000 barrels. The refinery will continue to be a straight-run plant, but is to be so arranged that cracking units may be added with little expense or trouble. New name of the company is to be Home Oil & Refining Company; it has a good trade with the mutual marketing companies in Montana and expects to cater to this particular line of trade.

Operating Experimental Unit

Root Refining Company, El Dorado, Arkansas, has begun operation of a new experimental cracking unit designed by J. R. McRea. The unit employs electricity as a heating medium. Experimental runs will be made for several months. The unit is semi-commercial size to test results of laboratory experiments.

Sinclair Expands Plant

Sinclair Refining Company, at its Houston, Texas, refinery, is building additional distillation facilities to increase capacity to 40,000 barrels daily. This is part of the two year enlargement program started early in 1930. In addition to topping stills, a new power plant and more tankage is being installed.

Small Kentucky Plant

Simrall Refining Corporation, Horse Cave, Kentucky, has started construction of a 500 to 1000-barrel refinery to operate on local crude and to distribute products locally. A pipe line has been built from the Horse Cave pool to the refinery, of sufficient capacity to furnish the plant and permit tank car shipment of crude to other refineries.

Russian Expansion Program

The Soviet Government has given its approval to the Combine of All-Russian Oil & Gas Industries, known in Russia as the Soyusneft, for an extensive program of building for the oil industry of the country, according to recent reports in The Petroleum World, London, England, which states that according to the semi-official advices the following erection is involved:

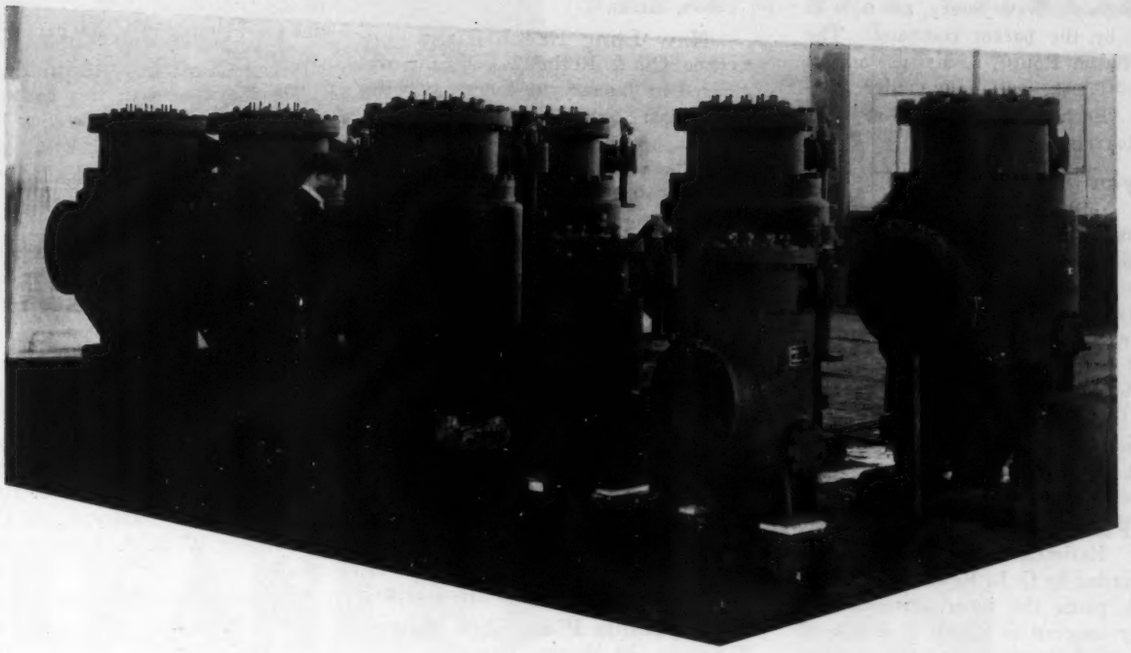
The Asneft Oil Trust will build a new kerosene and lubricating oil refinery with a capacity of 2,200,000 tons of crude annually, and the same organization to erect a gasoline-kerosene refinery with a capacity of 5,000,000 tons of crude per year, and a cracking installation capable of handling 6,500,000 tons of fuel oil yearly, with a secondary pipe still for redistillation of pressure distillate. Existing bright stock plants will be enlarged by addition of three tube stills to process 440,000 tons each, annually. The Badger kerosene lubricating oil plant will be enlarged by adding two vacuum stills to handle 260,000 tons of crude yearly.

The Grosneft Oil Trust will construct a new plant at Krasnodar to handle 440,000 tons per year. The same trust will build a light oil refinery at Grosny to handle 3,800,000 tons of crude annually, and will have cracking capacity of 5,850,000 tons of fuel oil per year. The Grosneft will enlarge its wax plants to 20,000 tons of wax per year and erect a new wax plant of equal capacity. A refinery will be built by the Sakhalineft, and the Grosneft and Asneft trusts will enlarge existing plants. It is further stated that all of the construction and enlargement will require the aid of American technicians. This program involves the addition of about 216,500 barrels crude oil capacity and 235,000 barrels cracking capacity to be installed in Russia during 1931 and 1932.

Six Hydrogenation Units

Standard Oil Company of New Jersey, through its subsidiaries, Standard Oil Company of Louisiana, and Humble Oil & Refining Company, expects to have six units of the hydrogenation process in op-

ECONOMICAL BAROMETRICS!



Ross Barometric Condensers, by operating at closest possible terminal differences, require the minimum quantity of water.

Ross Air Ejectors, because of the high efficiency to which they are designed, require the minimum quantity of steam.

The entire unit, because of its non-clogging design and rugged construction, eliminates maintenance charges.

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REFINERY AND GASOLINE PLANT ACTIVITIES

eration before the end of the year. Two units at Bayway, New Jersey, are now in operation by the parent company. The units at Baton Rouge, Louisiana, and at Baytown, Texas, are now under construction. Each unit has a rated capacity of 2500 barrels per day.

Taylor Plant Progressing

Taylor Natural Gasoline Company is completing construction work on a natural gasoline plant in the Chapman field, Williamson County, Texas, that will have a capacity of about 3000 gallons daily. Plans are to market the production in trucks at nearby refineries. Headquarters of the company are located at Taylor. R. C. Sowden is in charge of the plant. G. L. Rowsey, Taylor, and E. L. Chapman, Fort Worth, are principal owners of the company.

Plan East Texas Plant

Taylor Refining Company, Taylor, Texas, headed by G. L. Rowsey and E. L. Chapman, plans the incorporation of a subsidiary concern in which it will hold 51 per cent of the stock, for the purpose of erecting a 5000-barrel skimming plant at Tyler, Texas. Negotiations are pending for fuel oil contract with the Cotton Belt Railroad. Plans include a six-inch pipe line to connect with the Rusk County, Texas, fields.

New Long Beach Plant

Techna Oil & Refining Company was organized in January to operate a refinery on East 29th Street, Long Beach, California, for the manufacture of lubricating oils. The plant was finished in November, 1930, and has been operating with J. R. Trent in charge. Directors are residents of Long Beach.

Terra Bella Plant

Terra Bella Refining Company, Ltd., has been incorporated in California and has received permission to sell stock. Officers of the company are H. P. Mitchell, of Signal Hill, president; J. M. Bullard, Porterville, vice president; Frank Stevenson, Terra Bella, secretary, and F. L. Kennedy, Porterville, treasurer. The present company refinery is of semi-commercial experimental type, with a rated capacity of 50 barrels per day, designed for the principal production of lubricating oils.

Pennsylvania Plant Shut Down

Titusville Oil Works, Titusville, Pennsylvania, has shut down its complete refinery, and officers announce that no definite plans are made for resumption of operation. The plant has a rated capacity of 1000 barrels and a modern lubricating oil department. Cracking facilities are Fleming type, 200 barrels capacity.

Texas Company Acquires Indian

The Texas Corporation has announced acquisition of Indian Refining Company, through an exchange of stock. This gives the company another refinery with rated capacity of 17,000 barrels, and with 12,000 barrels cracking capacity of Cross and Dubbs units. The plant is complete, and produces lubricants through the use of the recently developed Govers Process.

A recent announcement by The Texas Corporation reads as follows:

"At a meeting of the stockholders of Indian Refining Company held in Augusta, Maine, January 22, 1931, the following directors were elected: C. B. Ames, Harvey Gibson, R. C. Holmes, H. T. Klein, F. T. Manley, E. A. Potter, Jr., T. Rieber, W. S. S. Rodgers, and P. C. Scullin.

"At the organization meeting of the directors, held in New York on January 23, 1931, the following officers were elected: President, R. C. Holmes; vice-president and general manager, P. C. Scullin; vice-president, W. T. Manley; vice-president, W. S. S. Rodgers; vice-president, S. B. Wright; secretary, E. M. Crone; treasurer, C. E. Woodridge.

Complete Plant at Winnepeg

Western Independent Refiners, Ltd., Winnepeg, has about completed construction of its new 2500-barrel refinery. This company is successor to Radio Oil & Gas Company, Ltd. and was financed by local capital. Ben Hecter is president and Max Hecter, vice-president. Don J. Blaize, who was formerly with Continental Oil Company, and the H. F. Wilcox Oil & Gas Company, is in charge of construction and plant operation. Operation is scheduled for February 15.

New Stabilizer Unit

White Star Refining Company, at its Trenton, Michigan, refinery, is installing a new stabilizer unit to handle Dubbs pressure distillate, with completion scheduled for April 1. Dubbs cracking capacity at this plant is 3900 barrels daily, with crude oil skimming capacity of 6000 barrels. White Star Refining Company is a Vacuum Oil Company subsidiary.

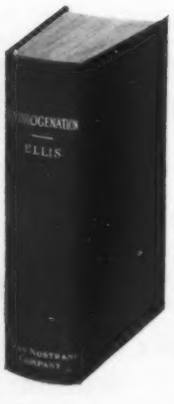
Montana Plant Shut Down

Yale Oil Corporation announced last month that it would temporarily shut down its Miles City, Montana, refinery—rated capacity 800 barrels. The company will continue to operate its Billings, Montana, plant—rated capacity 4000 barrels—taking 2000 barrels of crude per day.

HYDROGENATION

By CARLETON ELLIS

Starting with a clear account of the principles of hydrogenation catalysis, this book covers systematically the scientific work on the hydrogenation of individual organic compounds, and then presents exhaustively all the details of the industries themselves. The information in these pages has been compiled by the author over the many years of his career in this field. The researches, patents and inventions that have made him an outstanding authority on the subject of industrial hydrogenation tend to prove the value to you of this great book which has just been completed by the addition of new, hitherto unpublished information.



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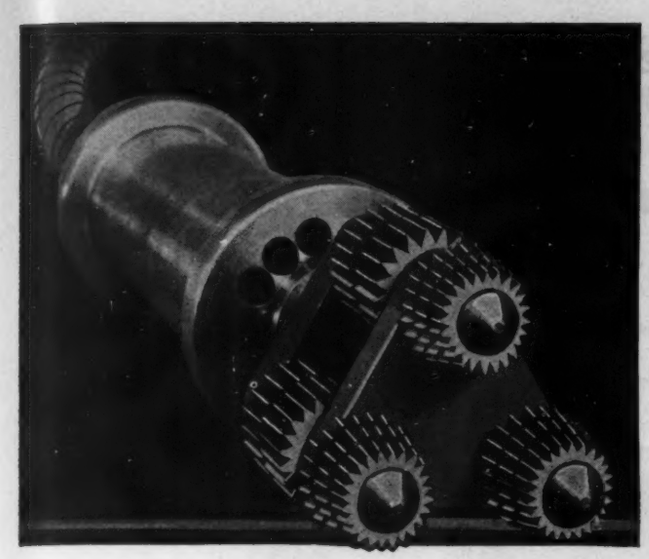

LIBERTY TUBE CLEANERS never quit!

The toughest of scale conditions cannot stop them. The "Tandemtype" Liberty particularly, with a double-powered motor driving its specially designed cutter head, can do a complete job—and do it rapidly.

Scale conditions vary, but you can always find a Liberty Cleaner adapted to the job of cleaning any tube or pipe in the plant, from 1¼ in. I.D. to 10 in. There is also the "Jiffy Gun" for shooting rubber plugs through condenser tubes. Write for the Liberty Catalog.

LIBERTY MANUFACTURING CO.
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JERGUSON

REFLEX GAGES

have been used for steam boilers for 25 years and are now being used by leading oil companies for indicating oil levels in tanks, towers, stills, etc.

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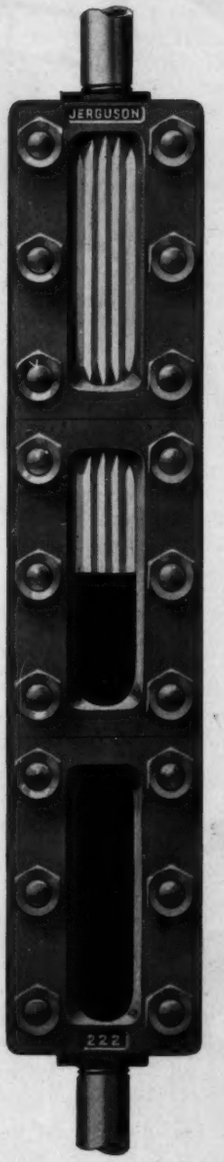

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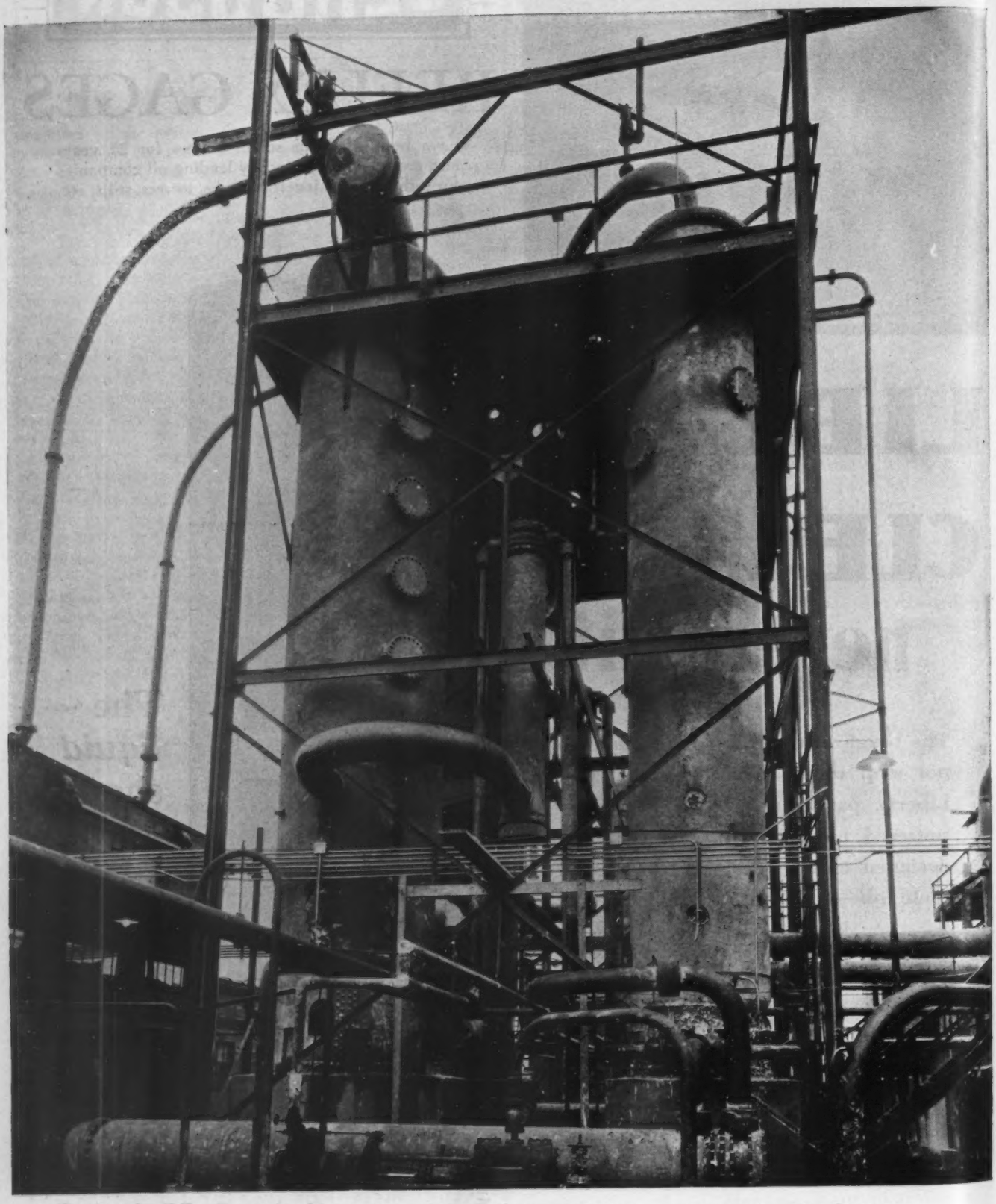

Installation of Bubble Towers and Evaporators recently completed for a prominent Mid-Continent Refiner.

J. P. DEVINE MANUFACTURING CO., INC.

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MT. VERNON, ILL.
Canadian Representative: John Inglis Co., Ltd., Toronto, Ont., Canada

Chicago Office
105 W. Madison Ave.

New Equipment for the Modern Plant

"Self-Contact" Pyrometer

UEHLING INSTRUMENT CO.

Uehling Instrument Company, 34 Vesper Street, Paterson, New Jersey, announces a new instrument for measuring and recording temperature. It is known as the "Self-Contact" petentiometer pyrometer. Either the thermocouple or an electric resistance bulb may be used as the temperature element.

It is designed to eliminate the use of depressor bars, cam mechanisms and continuously operating motors, these being eliminated by a patented method which gives definite contact between the needle of a galvanometer and stationary contact pieces without employing auxiliary mechanical devices.

This recorder is to permit placing the galvanometer apart, and at almost any distance from the recorder. The recorder, as illustrated, is actuated by a galvanometer that may be placed in any desired location. A single galvanometer will actuate as many as four recorders, each in a different location, each measuring a different temperature and each having an entirely different calibration.

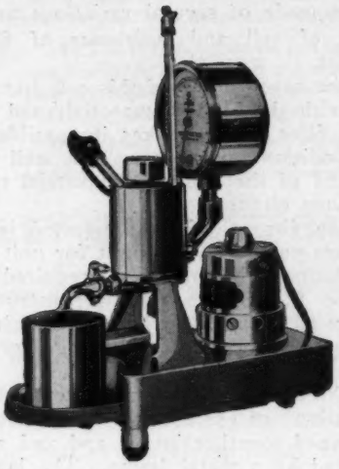
The entire recording mechanism is fastened to a frame which is hinged to the case. Everything may therefore be opened up to permit accessibility to all parts of the apparatus. A small motor operates only as and when necessary to adjust the pen to the proper temperature reading on a clock driven chart. It is also in geared connection with two pulleys over which a translucent endless belt, about two feet long, is placed. The belt is calibrated in temperature units and will move in direct proportion to the pen mechanism but at a greater speed. This permits an open and legible scale which moves in back of a pointer fastened to the door. The legibility of the figures, the exceptional length of the scale, and the fact that it is illuminated from the rear, make it very easily read under all conditions at a distance of 75 feet or more.

New Visco-Meter

VISCO-METER CORPORATION

Visco-Meter Corporation of Buffalo, New York, announces a new industrial visco-meter requiring only a few minutes for a complete test of viscosity over a range of temperatures. This instrument, as shown here, may be set up anywhere and requires no technical skill to operate. It is described as being accurate to within approximately one per cent.

The visco-meter employs a constant pressure rather than depending upon gravity to force the test liquid through the capillary tube. The viscosity readings are given directly by a gauge which is calibrated in Saybolt seconds. It is electrically operated and requires no additional apparatus. It occupies a single square foot of space and weighs about 15 pounds.



New Visco-Meter

It consists essentially of a small electric motor connected through a speed reducer to a gear pump which forces the test liquid through a calibrated capillary tube at a predetermined pressure, a special unloading valve to maintain constant pressure, a viscosity gauge, a thermometer tube to provide for convenient temperature readings and electric heating unit to heat the liquid.

The manufacturer may be written for further information on this instrument.

New Cooling Tower

THE MARLEY COMPANY

The Marley Company of Kansas City, Missouri, announces the development and placing on the market of an improved design in a spray deck cooling tower.

This new tower is of conventional deck type but has a different louvre system, in addition to a complete spray distributing system in the top of the tower. This louvre system operates to provide more air at uniform velocity, to eliminate excessive moisture entrainment and to reduce drift losses to a minimum. It envolves the use of two separate and distinct sets of louvres. The first, or primary louvres are solid, being inclined outward and upward away from the tower. The secondary louvres are placed essentially at right angles to the primary louvres and extend across the entire space between them.

The primary louvres are placed adjacent to each deck for effectively caring for the splash or rebound created by water impacting against the decks. They lean outward and away from the tower, permitting air flow horizontally and to all parts of the tower with but slight change of direction. The width of the opening between the primary louvres is nearly double. The secondary louvres are spaced to give the right added draft resistance to compensate for opening up the primary louvres, at the same time forcing air equally to all parts of the tower.

Air leaves the deck area, passing outward with uniform velocity, thus eliminating excessive moisture entrainment. Where moisture is entrained it is deposited on the exit secondary louvres, which also serve as effective drift eliminators. The net result is more air at reduced maximum velocity.

The spray system in the top of the tower is supplied by means of a main distributing header to which all nozzles are attached. Pipe sizes are large and friction losses are reduced. Pressure is equalized throughout the entire header.

Marley decks are of redwood with a rough surface and are arranged and spaced so that all falling water is arrested and splashed at each deck. Air can flow freely upward or downward through the decks because of the 50 per cent free area provided.

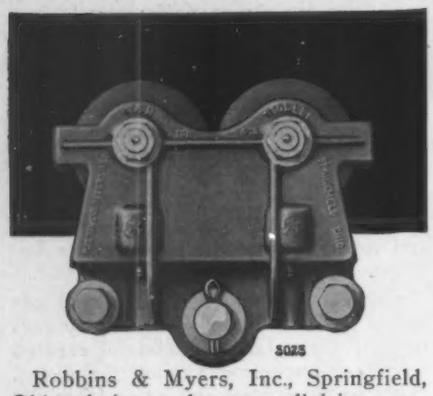
The Marley Company has just prepared a new catalog giving details of this new tower and will be glad to send copies to interested individuals and firms.

Marley Cooling Tower

NEW EQUIPMENT FOR THE MODERN PLANT

New Ace Trolley

ROBBINS & MYERS, INC.



Robbins & Myers, Inc., Springfield, Ohio, hoist and crane division, announces the new Ace trolley in plain and geared types ranging from one-half to 20-ton capacity.

The Ace trolley has a heavy ribbed malleable iron frame, chilled and crowned trolley wheels of high tensile strength Aremite with treads machine ground to a perfect circle, and the R. & M. combination of eight Timken and four Hyatt roller bearings. Safety lugs and wheel guards are included in the design to prevent the trolley from falling in the event of wheel or stud failure. Smaller sizes of this trolley are adjustable to seven I-beam sizes. Axel studs are drilled for Zerk-Alemite lubrication, and felt washers on both sides of the trolley wheels serve to retain the lubricant and keep out dust.

Bulletin 5025, covering the complete line of Ace trolleys, is now ready for distribution by the manufacturer, along with other literature describing the Robbins & Myers hand and electric hoists and cranes of every type.

Burt Fiber Air Filter

BURT AIR FILTER CORPORATION

Burt Air Filter Corporation, Akron, Ohio, announces the Burt fiber air filter which offers something new in the field of air filters. It is distinctly a dry type filter and employs for its filter media a pad which is made up of layers of cloth fiber of various densities. It is made of several variations as to size of cell and resistance of filter media.

Burt Air Filter

The construction of this cell, together with the kind of material used for this filter media, makes it possible to recondition and clean this cell by means of the ordinary industrial type vacuum cleaner.

The fibre air filter illustrated is 20 inches square and is built for unit installations. No frames are required because the cell is rigidly constructed from steel and is designed so the individual units can be bolted together into an air-tight installation.

The filter media is made from a combination of jute and cloth fibers clamped together into a pad and supported by a metal frame. The layers of jute and cloth are arranged in layers of varying density with the coarser woven material on the air intake side of the filter. The larger particles of suspended matter are removed at the point and the finer woven layers on the air outlet side remove the smaller bits of dust.

A bulletin completely describing the design, construction and working arrangement of this new filter will be mailed upon request to the manufacturers.

"400 Mesh" Wire Cloth

NEWARK WIRE CLOTH COMPANY

Newark Wire Cloth Company, Newark, New Jersey, announces the manufacture of a wire cloth having 160,000 square openings per square inch. It is "400 mesh" wire cloth with 400 parallel wires per inch of width running each way, at right angles. This allows 1,000,000 microscopic openings in a piece of wire cloth slightly more than six square inches area, or only 2½ inches square.

Prior to the making of the "400 mesh" cloth the finest wire cloth was 325 mesh, a product of the same company. It is known as sieve number 325 by the U. S. Bureau of Standards, and has been adopted as standard by the American Society of Testing Materials, according to the announcement.

Newark Wire Cloth Company for many years has found it necessary to draw all of its own fine wire for the manufacture of this cloth. Prior to 1912, American manufacturers encountered much difficulty in fabricating wire cloths finer than 100 meshes to the inch, and most of the wire cloth used in the United States was imported from foreign countries. At that time experimental work was started in weaving a piece of 200-mesh cloth of a special metal for a large laboratory. A piece of 200-mesh cloth 34 inches by 100 feet was completed, using this special metal of a diameter of 0.0021 inch.

Newark Wire Cloth Company will furnish upon request complete information regarding this newly developed 400 mesh wire cloth. The wire cloth is made of all malleable metals from steel to gold and platinum, in as many meshes, sizes, weaves, widths and lengths.

New Vent Valve

VAPOR RECOVERY SYSTEMS COMPANY

Vapor Recovery Systems Company, Compton, California, announces a new conservation vent valve for oil tanks.

Frank V. Long, president of the company, describes this valve, which is known as the Varco breather valve, as being made of pure aluminum throughout and as incorporating the same features as the company's Toncan iron valve of high flow capacity. It is designed to eliminate winddrift by utilizing a single passage way common to both vacuum and pressure relief. It is made of aluminum material in order to be applicable on tanks containing oil which gives off corrosive gases, on cracking plant run-down tanks, caustic tanks, and other tanks carrying corrosive ments.

Pure aluminum seats are installed in such a way as to permit easy replacement. The announcement states that, if desired, seats may be of lead, stainless steel or any other metal. Another object of the aluminum material, it is explained, is to give light weight to the valves.

Tests have been made showing the stream line design of the valve body and static balance valves results in a flow capacity of 98 per cent of an open nipple, and that it prevents chatter in the valve.

More detailed information on this vent valve is available upon request to the manufacturers.

Model CP Oil Pump

TUTHILL PUMP COMPANY

Tuthill Pump Company, 131 West 63rd Street, Chicago, announces a new ball-bearing Model CP oil pump primarily intended for handling all lubricating liquids.

The new pumps are of the rotary, internal gear, positive delivery type with improved stuffing box and the ball-bearing feature incorporated; and are built to handle pressures up to 200 pounds per square inch on liquids with fair lubricating qualities. Four sizes are available ranging in capacity from 2 g.p.m. at 300 r.p.m. to 40 g.p.m. at 1200 r.p.m.

Construction features include ball-bearings to absorb the thrust and radial loads of the rotor, compactness, and a new standard mounting design, primarily arranged for end mounting with an optional bracket for users desiring foot type of mounting.

Operating features include development

Facts About Firebrick Joints

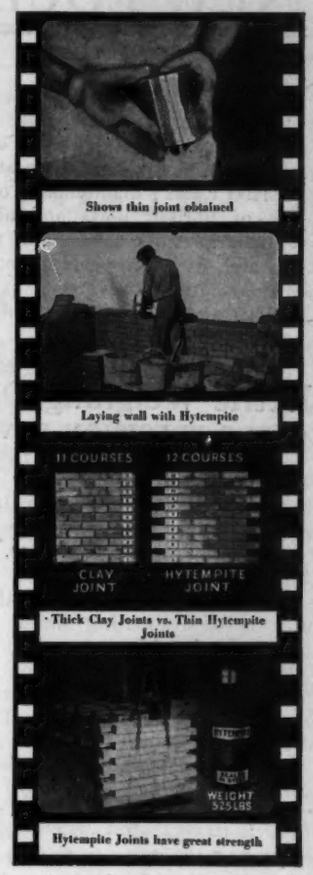
Fourteen years ago we strongly urged the use of a thin cement joint for firebrick construction in place of the thick fire clay joint which was then the general practice.

Today the thin joint is generally recommended by firebrick masons and firebrick manufacturers as they now produce high quality brick and tile that are true to size and shape.

Select the brick best suited to your needs, bond them with HYTEMPITE and you make certain the best refractory service.

HYTEMPITE joints do not erode as there's practically no joint—just a brick to brick surface throughout the structure—*No Shrinkage —No Cracks—No Leakage.*

Thick joints of Hytempite mixed with crushed fire brick can be used when the lack of uniformity of brick makes a thick joint necessary.



Hytempite is packed in steel air-tight containers of the following weights: 800 lbs., 400 lbs., 250 lbs. and 100 lbs.

QUIGLEY GAS-TITE BAFFLES

for boilers and stills are made of crushed old firebrick bonded with Hytempite. This mixture is either tamped in place against a lattice-work form or "shot" with the Quigley Refractory Gun. They are now installed in boilers with a total capacity of over 500,000 B.H.P.

Ask for Folder BR 136.

QUIGLEY COMPANY INC.

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56 West 45th Street, New York

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The New TAG Saybolt Viscosimeter

With Motor Stirrer and Automatic Temperature Control

ADDED convenience, much more accurate determinations and the resultant lessening in the time required for the tests, make it almost imperative that you replace or augment your old Saybolt baths with this remarkable new one. The price is only slightly higher than that of the old type Saybolt Viscosimeter while the Motor Stirrer, Automatic Temperature Control, Cooling Coil and many other new features are of vital importance and worth many times the small increase in cost.

Write for Bulletin 1006-52, prices and our liberal allowance offer.

C. J. TAGLIABUE MFG. CO.

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Instruments for Indicating, Recording and Controlling

C. J. TAGLIABUE Mfg. Co. BROOKLYN

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of pressures up to 200 pounds per square inch; efficiency in performance as high as 70 per cent on good grades of lubricating oil; direct-motor drive at speeds up to 1200 r.p.m.; maintenance of prime by use of upright ports and ability to drive pump in either direction of rotation, suction and discharge ports interchanging when the rotation is reversed.

Catalogs and prices are available upon request.

Electric Weighing Device

TOLEDO PRECISION DEVICES, INC.

Toledo Precision Devices, Inc., a subsidiary of the Toledo Scale Company, Toledo, Ohio, announces an electric cut off weighing device.

This device has two dials, on the front and back side of the scale head. The cut off indicating hand, on the back of the head is set to the desired weight. The weight indicator on the front of the head stands at zero when there is no load on the scale. The substance to be weighed is then allowed to flow into a container on the scale. During this process the cut off indicator gradually returns to zero, and the weight indicator advances toward the desired weight. When the cut off indicating hand reaches zero it covers the slot which is located over the electric eye. This cuts the light which comes from a bulb placed over the slot, and this in turn causes the electric eye to make a contact which travels to the relay which operates the solenoid valve, or any similar cut off switch.

This device is applicable to any predetermined weighing operation. It is recommended for use in oil refineries, or any industry where definite quantities of a product are repeatedly weighed.

The electric cut off weighing device is designed to insure exact weight, is automatically operated and may be attached to any form of endless conveyor, continuous filler, or mass production packaging machine.

Electric Welding Device

Foam Device

AMERICAN LaFRANCE AND FOAMITE CORPORATION

American LaFrance and Foamite Corporation of Elmira, New York, announces a new foam producing device, known as the Foamite Duomixer.

The new device is used in a system known as the Foamite dual powder system. Designed primarily for stationary use, the Duomixer is a two-hopper device, one hopper being used for the "A" part of the Foamite dual powder, and the other for the "B" part.

Because the "A" and "B" parts of the powder are poured into separate hoppers, foam is not produced at the Duomixer as is the case with single powder Foamite generators manufactured by the company. Instead, the resulting solutions flow through twin pipe lines, terminating in mixing chambers or nozzle sets. With this set-up, the Duomixer may be located as far as 1500 feet from the risk to be protected. This feature, it is announced, is one of the principal reasons for the existence of the Duomixer and the Foamite dual powder system.

Foamite dual powder for use in the system, is packed in moisture proof steel containers, each holding 50 pounds. Those containing the "A" part of the powder are painted yellow with black lettering, while those containing the "B" part are black with yellow lettering. The two hoppers of the Duomixer are painted and lettered to correspond.

Three models of the Duomixer are now in production. They are designated as models 120, 275 and 350. The numbers indicate the inlet capacity in gallons per minute at 100 pounds water pressure, the recommended operating pressure. With the exception of the sizes of the orifices, all models are identical.

In many ways, it is pointed out, the dual powder system, utilizing the Duomixer, will resemble the Foamite two-solution system which is today used in protecting millions of barrels of petroleum products all over the world. It incorporates many of the features of this system, such as twin pipe lines, mixing chambers, hydrants and control valves. Like the Foamite two-solution system, the Foamite dual powder system has a centralized point for the discharge of the solutions.

For portable use alone, it is claimed that no foam producing device is as simple and rapid in operation as a single hopper generator using a single foam powder. Although the commonest application for the new Duomixer will be in a fixed installation, it may, in an emergency, be used as a portable device. In such service, it requires twin lines of 2½-inch hose terminating in a Foamite nozzle set.

"Linc-Weld" Induction Motor

LINCOLN ELECTRIC COMPANY

Lincoln Electric Company, Cleveland, announces a totally enclosed, fan cooled, induction motor which embodies numerous new features. The motor is so designed that its rise in temperature is slight. The design includes arc welded steel construction, double sealed ball bearings, and a removable cover to facilitate easy cleaning of the unusually large radiating surface.

The large radiating surface is obtained by complete enclosure of sides of the motor with a deeply corrugated sheet of corrosion resisting metal. This conducts the heat created within the motor to its outer radiating surface which is constantly cooled by a continual draft of fresh air passing over the radiating surface.

The air imprisoned within the completely sealed frame is circulated by a

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CARMACO

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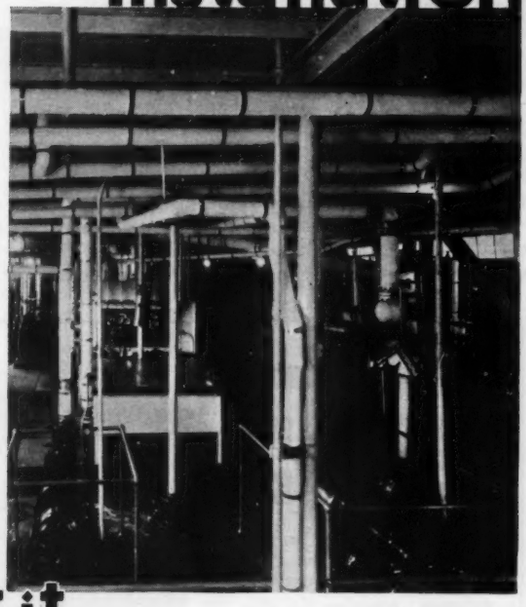

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Power Piping
FOR EVERY INDUSTRIAL NEED

One order may call for a mere fitting, another for pipe bends for oil field work, still another may require high pressure piping in a process plant! In any event the experience of Power Piping Company is varied enough to meet any piping need. Design, fabrication, erection, complete supervision—any phase of piping service with economy and dispatch.

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PITTSBURGH, PA.

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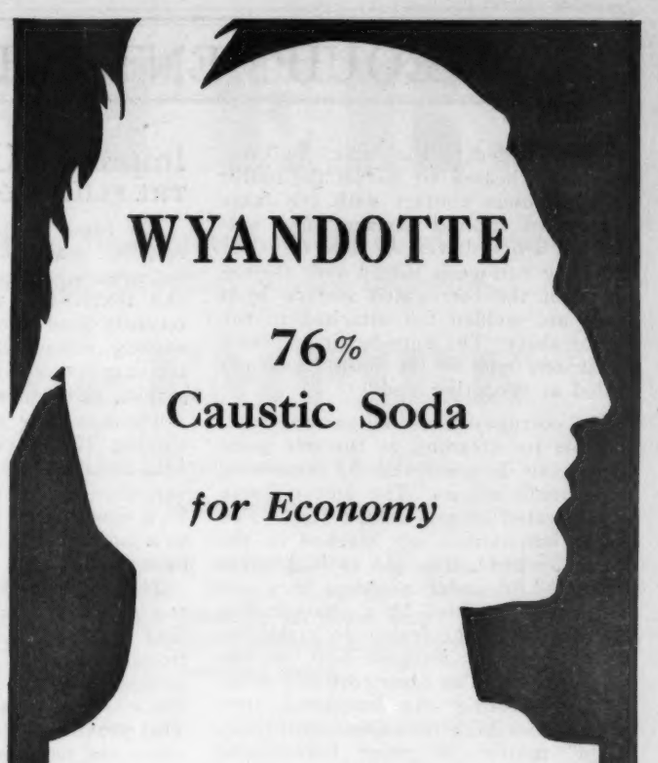

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76% Caustic Soda

for Economy

WITH the robust investment that you put into every bake, it is comforting to know that you are providing for continuous successful production when you use Wyandotte 76% Caustic Soda.

Through its consistent uniformity and high quality, Wyandotte aids in holding down production time and other costs. Lower your costs and you make more money.

Where even slight variations of purity or quality can cause losses, economy suggests that you use Wyandotte.

Also Soda Ash, Bicarbonate of Soda and Calcium Chloride.

"Distinguished for its high test and uniform quality."

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General Sales Department
10 East 40th Street, New York City

Chicago Office: 1316 South Canal Street
Works: Wyandotte, Michigan

NEW EQUIPMENT FOR THE MODERN PLANT

fan arc welded to the rotar. This fan drives the heated air within the motor to continuous contact with the large corrugated cooling surface. The outside air which drives the heat from the radiating surface is forced over the exterior of the corrugated surface by a large arc welded fan attached to the motor shaft. The outside air is drawn in at one end of the motor and expelled at the other end.

The corrugated cooling surface is accessible for cleaning as the one piece cover can be removed by loosening two thumb screws. The motor frame is fabricated of arc welded steel. The stator laminations are stacked in the frame by hand, then put to high pressure. While under pressure they are permanently affixed by a retainer ring arc welded to the frame, to make the stator core an integral part of the motor frame. The rotar core is formed by hot riveting the laminated iron while under high pressure. On "Linc-Weld" motors 28 gauge laminations are used both on the stator and rotor cores.

This new "Linc-Weld" motor has the same mounting dimensions as standard, open type, horizontal motors of equal rating. It is manufactured in sizes from 1 to 50 H.P.

Improved Cooling Tower

THE FLUOR CORPORATION, LTD.

The Fluor Corporation, Limited, Los Angeles, manufacturers of Fluor cooling towers, announce that a number of new features of advanced design have recently been incorporated in the Fluor cooling tower which tend to greatly increase its efficiency, as well as simplifying and standardizing construction.

The company explains that in redesigning the tower, expressions were first obtained from customers as to the various features they desired included in a tower, and with this information as a guide, Fluor Corporation engineers have produced the new tower.

The primary distributing system on top of the tower has been revised so that in place of the old flume and troughs, a pipe system is now used in conjunction with a modification of the Fluor bowed type double paneled back. This provides for better distribution of water and requires no adjustment, since there are no troughs to get out of level; and the growth of algae does not affect distribution. Permanently uniform distribution allows all the surface provided in the tower to be utilized, obtaining lower temperatures.

Another feature is a louvre to reduce spray loss caused by wind velocity so that the tower offers maximum obstruction to the water tending to get out of the tower, and yet does not prevent free circulation of air. A complete and detailed description of the new Fluor tower will be forwarded upon request to the company.

Steam Turbine

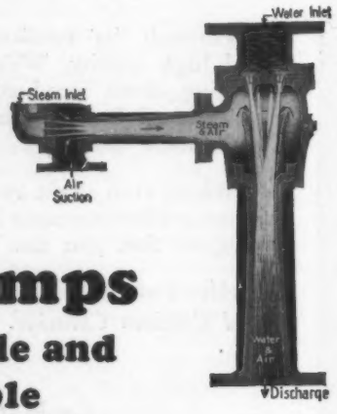
GENERAL ELECTRIC COMPANY

General Electric Company, Schenectady, New York, announces a new small mechanical-drive non-condensing steam turbine for driving centrifugal pumps, fans and similar industrial equipment operating in general at speeds between 1750 and 3600 r.p.m.

The new turbine is built only as a single-stage machine and has two rows of revolving buckets. It follows the design of the standard line of G. E. mechanical-drive turbines. The wheel casing is split horizontally for easy access to the internal parts, and the steam and exhaust pipes are connected to the lower half of the machine. A new centrifugal governor with weights pivoting on knife edges operates with very little friction and provides proper speed regulation. An independent emergency governor is included. The new turbine bears the type designation D-57.

S&K Steam Jet Air Pumps

Are Simple and Reliable



Use them in refinery work

Five styles, five standard sizes in each

The S&K Hydro-Steam Air Pump shown above operates without inter- or after-condenser

Bulletin 5-H gives complete information.

SCHUTTE KOERTING 1253 N. 12th Street, PHILADELPHIA

American Petroleum Refining

By **H. S. BELL, C. E.**

Every detail of American refinery practice — the most up-to-date developments as well as the standard methods — are fully covered in this book. Vapor phase craking, the production of high compression gasoline, the development of modern pipe stills, the use of Diesel engines in oil pumping, and hundreds of other subjects of equal interest and importance, are discussed, covering in full every detail of oil refinery operation, engineering, and design.

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METERS

For Accurate Measurement of Oil at any Stage of Refining, Shipping, Storage or Selling.

The EMPIRE

A Positive Displacement Oscillating Piston Design

Highly accurate. Strong and durable. Easy to install. Economical to maintain. Simple to operate. Requires no complicated servicing. Made in all sizes, from 5/8" to 6", in standard (150 lbs. working pressure to square inch) and high pressure (300 lbs. and up) types.

Send postal for fully descriptive pamphlet 125-R.

The EMPIRE is different from every other type of meter offered for oil measuring work. The action of its measuring unit is a gentle, almost floating motion, with balanced pressures and a minimum of friction. This unique design enables the EMPIRE to hold its original high accuracy under operating conditions that quickly destroy the value of other types.

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We make metal gaskets of any size or shape, plain or corrugated, with or without asbestos, also plain solid washers of copper, aluminum, monel metal or any material desired. Our Gasket Guide shows a very complete line of gaskets suitable for refinery work.

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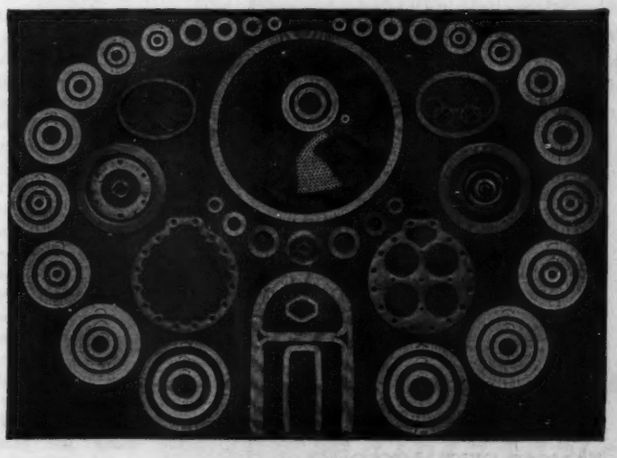

A Few Types of Goetze Gaskets

ITEMS ABOUT MANUFACTURERS

Alloy Welding & Manufacturing Company, Pittsburgh, announces the appointment of Leo Schaedle as the company's Midwestern representative, with offices at 950 Dierks Building, Kansas City. Mr. Schaedle, an engineer, was formerly located at Pittsburgh.

Byron Jackson Company, Berkeley, California, announces that, effective February 1, its Eastern office is located at Bethlehem, Pennsylvania, instead of 1245 Graybar Building, New York City, as heretofore. While sales offices will be maintained in New York City, correspondence for the Eastern Division of the company should be addressed to P. O. Box 409 Bethlehem, according to the announcement.

American Meter Company, Albany, New York, has made additions to the floor space, equipment and personnel of the Albany laboratory. The laboratory now occupies an area of 950 square feet. It specializes in experimental and testing work relative to low pressure measurement. Activities are co-ordinated with the company's research laboratory at Metric Metal Works, Erie, Pennsylvania.

To facilitate proving tests with both large and small meters, the laboratory is equipped with a five cubic foot, a 10 cubic foot and a 100 cubic foot prover. The size of the laboratory is such as to permit the installations of additional equipment and apparatus as needed.

Alsop Engineering Corporation, 39 West 60th Street, New York City, announces a full-floating asbestos, which has been compounded by an entirely different process in a new type machine designed by the company's engineers. This announcement is made after five years of experimenting with asbestos filtering compounds for use in over 1000 gravity asbestos filters. The company announces that samples and prices will be submitted to anyone interested provided the type machine and quantities used per year are given in the request.

The Cooling Tower Company, Inc., 15 John Street, New York City, announces the publication of Bulletin 303, on atmospheric cooling towers. This is an eight-page bulletin, profusely illustrated with photographs of the various types of towers manufactured by this company, and illustrated also with cooling curves. "How to Figure the Size Cooling Tower Required" is an interesting section, covering refrigeration, internal combustion engines and steam condensers. A copy of the bulletin is available upon request.

Coppus Engineering Corporation, manufacturers of ventilating and mechanical draft equipment, blowers, turbines and turbo generators, announces a new bulletin on its equipment for oil refineries. It gives a comprehensive idea of the type of equipment made by the company for special application to the refining industry and is profusely illustrated. A copy of the bulletin is available by addressing the manufacturers at the main plant, 344 Park Avenue, Worcester, Massachusetts.

William T. Graham, superintendent of field construction, A. O. Smith Corporation, Milwaukee, travelled 80,000 miles in the past 1½ years, by airplane, following the adoption by the company of a modern method of keeping in touch with construction crews operating simultaneously in all parts of the country. A Waco "10" plane, powered with a Wright Whirlwind 220 horsepower motor, is being used by him for this work. Decision to travel by plane followed an inspection trip of four weeks, covering 6000 miles, in which Graham was riding between jobs three weeks and actually working only one week. While Graham was a licensed pilot before the purchase of the plane by his company, the Waco "10" was equipped with dual controls, and he was accompanied by another pilot on the first few trips. Only one trip has been necessarily abandoned since he started using the plane and this was in Wyoming when the temperature was 40 degrees below zero.

William T. Graham and his plane

A. C. Dunthorne, A. M. I. C. E. of the Whessoe Foundry & Engineering Company, Ltd., Darlington, England, British engineer, is spending a few weeks in Cleveland, consulting with officials and engineers of Arthur G. McKee & Company, engineers and contractors. The Whessoe Company recently became exclusive manufacturing agents in Great Britain for the manufacture of McKee oil refinery and blast furnace equipment.

The Duriron Company, Inc., Dayton, Ohio, has issued a four-page folder covering a new line of alloy steel valves, resistant to corrosives, pressures and heat. This valve is a new product of the company, and is completely described and pictured in this folder, which is available by writing the manufacturers.

M. H. Detrick Company, 140 South Dearborn Street, Chicago, has issued a new 80-page catalog arranged as a handbook for refractory furnace engineers. Several sections are devoted to explaining the underlying principles of Detrick air cooled walls and arches with photographic illustrations of the structural elements used. Other sections exhibit numbers of representative installations. In still other sections there are useful tables and charts for calculating the heat transfer through refractories, figuring the air required for cooling, and giving general information that the designer constantly requires.

Fuller Lehigh Company of Fullerton, Pennsylvania, has issued Bulletin No. 5-80, describing and illustrating the new type B. pulverizer.

The bulletin is well illustrated and describes in detail the construction and operation of the mill. Outstanding features include the spherical-ball and grinding ring principle of pulverizing in which fineness is not affected by wear of grinding parts, and the enclosure of all parts requiring lubrication in dust-and-oil tight housings apart from the grinding zone.

The method of obtaining pressure between the balls and the grinding rings, any amount desired, also is illustrated. This feature, combined with the use of two full rows of balls grinding at low speed, has resulted in a quiet and smooth running pulverizer of high capacity and fineness.

Copies of the bulletin are available on request to the company.

A. P. Green Fire Brick Company, Mexico, Missouri, has recently issued its first printed matter for general distribution dealing with the new Mexko fire brick, produced more than a

Electrically Driven Centrifuges
Hand Centrifuges
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WILLIAMS, BROWN & EARLE, Inc.
Manufacturers of Laboratory Apparatus
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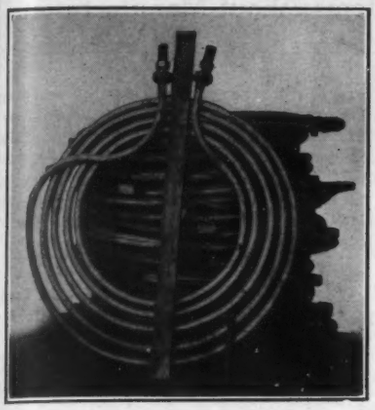
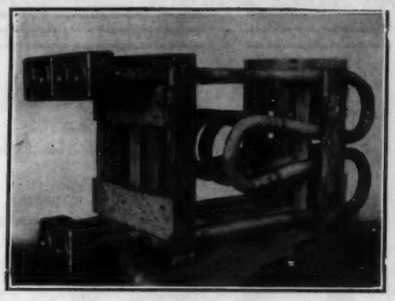


HEATING COILS

Will Alloy Pipe Solve Your Problem?



ALLOY PIPE PREHEATER

Alloy Pipe Fabrication for Every Purpose

Corrosion Resisting—Heat Resisting—Stainless

With a background of twenty-five years of experience in high pressure piping along with our wide experience in the fabrication of alloy steels, we are thoroughly equipped to produce units of all descriptions. Let us quote you on your requirements.

Coils, Bends, Headers

AGITATORS
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KETTLES
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RETORTS
TANKS
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STILL PARTS
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TANK PARTS
STEAM VALVES
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ALLOY WELDING & MANUFACTURING CO.

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Check up on Filters

Bought by the Petroleum Industry

They're practically all Oliver United.

For contact work, doctor solution, refiltering of lube-oils, residuum treatment . . . these are places where Oliver United filters of one type or another are in use.

And the reason for this wide spread use is that Oliver United engineers have made a thorough study of the application of filters to oil refining problems and they have the widest variety of types from which to select the most suitable unit.

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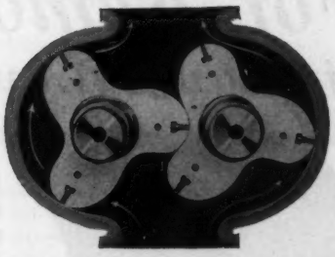
POSITIVE DISPLACEMENT ROTARY PUMPS



Like the piston type, the Waterous Rotary Pump is self-priming and of positive displacement; like the centrifugal it has no valves, has continuous flow, and is smooth in operation. The Waterous might easily solve your pumping problem. Send complete information with your inquiry.

Waterous Dependable

Agents in Principal Cities
WATEROUS COMPANY
St. Paul, Minn.

WATEROUS *dependable*

R. S. MANOMETERS

Another AC-ME PRODUCT!

(Accurate Measurement)

The R. S. Manometer is made of a one-piece Pyrex glass U-tube which is amply protected by a cast aluminum body. The glass is packed at the top by means of a stainless steel compression fitting and cork packing. The lower end is held in place by means of cork gaskets and a small aluminum plate. The aluminum plate protects the lower end of the glass tube from the shocks which might otherwise break the tube. Broken glass tubes can be very easily and quickly replaced making a tight connection by means of the cork gasket and compression fitting.

This manometer can be used to determine very accurately any pressure, vacuum, or differential pressure within its range, and can be used on line pressures up to 250 lbs. per sq. inch.

The scale for the manometer is made adjustable in order to facilitate reading by zeroing the scale. The scale is wide enough to protrude slightly over the glass tubes so that an accurate reading can be very easily taken. The manometer may be obtained with scales of various ranges.

Our Bulletin 15-R further describes this instrument as well as our complete line of scientific AC-ME equipment. Write for it!

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For Remote Control

of Liquid Levels in Refining

THE rate of flow from Stills, Vaporizers, Bubble Towers and Dephlegmators must be controlled in order to maintain the necessary level of the contained condensates. The sure, safe and satisfactory system of exercising remote control is represented by the horizontal-float type *VIGILANT Liquid Level Regulator.* Details upon request.

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28-40 Penn Avenue, Pittsburgh, Pa.

Organized 1884—Oldest Builders of Gas Regulators in the country. Built in all sizes from 1 inch to 24 inches; for all Service. 1 oz. up to 2,000 lbs. pressure to square inch.

Representatives:

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Sales and Service
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JNO. W. CRAWFORD
Sales Engineer
1855 Industrial Street Los Angeles

Or Any Jobber

CF VIGILANT
LIQUID LEVEL
REGULATORS

Items About Manufacturers

year ago with the definite idea of resisting spalling action. Since the making of this special brick tests have been made under working conditions to demonstrate the success of the product. It is a neat booklet covering 20 pages, and illustrated throughout. A copy of this booklet, covering completely the new Mexko fire brick, is available upon request.

H. W. Hardinge, president of Hardinge Company, sailed January 4 on the Mauretania for Europe, to be gone two months on business.

L. H. Clouser, formerly instructor of Sanitary Engineering at Penn State College, State College, Pennsylvania, is now associated with the Sanitation Department of the Hardinge Company. Prior to his work at Penn State, Clouser was with William Dechant & Sons Reading, Pennsylvania.

The Lummus Company, a new engineering and contracting firm having authorized capital stock of $10,000,000, has been organized to take over the business of Walter E. Lummus Company of Boston. The Superheater Company and Babcock & Wilcox Company hold substantial blocks of stock in the new firm.

The Lummus Company will engage in the design and manufacture of distillation and refining equipment for the alcohol, chemical, and petroleum industries, thus following the lines of activity pursued by Walter E. Lummus Company, but operating on a larger scale.

The facilities and experience of The Superheater Company and Babcock & Wilcox Company combined with those of the Lummus organization will, it is claimed by Walter E. Lummus, president of the new company, provide a well rounded and scientific organization.

Walter E. Lummus Company of Boston is an organization known in the distillation field for 30 years. The Superheater Company has extensive manufacturing plants at East Chicago and Sherbrooke, Quebec, and has built heat transfer equipment for the refining field, particularly in the form of tubular heaters. Babcock & Wilcox was incorporated in 1881, and manufactures water tube steam boilers for stationary and marine service. The company also manufactures stokers, economizers, oil burners and other power plant auxiliaries. Babcock & Wilcox works are located at Bayonne, New Jersey, Barberton, Ohio; East Liverpool, Ohio; and Augusta, Georgia. A subsidiary company operates a tube mill at Beaver Falls, Pennsylvania.

Walter E. Lummus is president and treasurer of the company and Raymond R. Collins is vice-president and secretary. Directors, aside from these two men, include George L. Bourne, F. J. Faulks, F. A. Schaff, C. W. Middleton and A. G. Pratt.

The Marley Company, Kansas City, Missouri, announces the opening of a direct district sales office in New York, at 6 East 45th Street, with J. C. Albright in charge as district manager. He formerly served Bailey Meter Company.

McIntosh & Seymour Corporation, Auburn, New York, announces the election of R. B. McColl as president and a director of the corporation, succeeding A. E. Ballin, who retired, effective February 1.

Born in Kilmarnock, Scotland, in 1882, McColl spent practically all of his working career until the present time in the railway and locomotive industry, in England and Canada. After approximately 15 years experience in locomo-

THE HOIST THAT DOES NOT REQUIRE REPAIRS FOR YEARS.

UNION Spur Gear Hoists

Five years is our guarantee. They are remarkably free from the petty troubles and repairs which are characteristic of an ordinary hoist. They are backed by a reputation of fifty years' standing, for integrity of construction.

UNION HOISTS have the most accurately cut and highest quality steel, heat-treated gear system ever used in any hoist. Union cut steel gears insure easier operation, less maintenance, and longer wear.

MADE BY THE MAKERS OF

UNION CHUCKS

Complete new hoist and chuck catalogues on request.

Union Manufacturing Co.

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Branch Offices Carrying Stocks: NEW YORK, 26 Cortlandt St.; CINCINNATI, 332 Sycamore St.; CHICAGO, 27 S. Jefferson St.; SAN FRANCISCO, 661 Folsom St.; HOUSTON, I. Van Tassel, 1120 Union National Bank Building.

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Affords an economical and efficient means for removing dirt and moisture from oil and gasoline.

As a final finishing step before barreling or packaging, by passing the oil through a Shriver Blotter Press, the pipe line and tank accumulations of dirt and moisture are eliminated from the finished oil which assures an absolutely clean product.

Also, Shriver Blotter Presses are especially recommended for brightening up or polishing contacted oils.

Your inquiries are solicited.

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Established 1860

848 HAMILTON ST. HARRISON, N. J.

A FILTER PRESS FOR EVERY PURPOSE

SHRIVER (T. SHRIVER & CO. HARRISON N.J. FILTER PRESSES)

FILTER PRESSES FILTER CLOTH . DIAPHRAGM PUMPS

A Real Substantial, Durable Valve for Your Various Acid Conditions

Carolina ACID VALVES

Made of Lead Alloy, Special Cast Iron and of Various Alloys to Suit Acid Conditions

1. Renewable plugs and stems.
2. Renewable seats.
3. Rising stem with very short travel.
4. Extra long stuffing box that can be packed while in operation.
5. Studs for packing gland operate from top of yoke so that they will not come in contact with acid in case of leaks around stuffing box.
6. Stuffing box can be packed while in operation.
7. Amply large hand wheel.
8. No sticking.
9. Extremely heavy construction and very durable.
10. That part of valve stem that has been in the acid does not protrude above the stuffing box.
11. Absolutely acid resisting.
12. Constructed of various alloys to suit your acid conditions.
13. Drainage gland around the stuffing box in case of leak.

Made in either straight line or angle type.

Charlotte Chemical Laboratories

CHARLOTTE, N. C.—*New York Office:* 50 E. 42 St.

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Designed by Engineers with 25 Years Experience in Acid Plants

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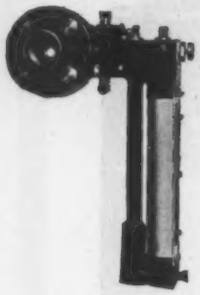
FLOW INDICATORS



Close-hook-up Type Flow Indicator

DIRECT READING
(In any Units desired)

ACCURATE

COMPACT

FOR ANY SERVICE

Send for Bulletin No. 204-B

MOREY & JONES, LTD.

Manufacturing Engineers

920 So. Hemlock St. **Los Angeles, Calif.**

Watermelon and Pumpkinseed

We are frequently asked why we apply such names as "Watermelon" and "Pumpkinseed" to

CAMPBELL
Steam Flow Controllers for Oil Stills

By comparing the two photographs at the left you can "see" why. The body of the top photo is shaped like a watermelon and the lower one like a pumpkinseed. But, after all, the name of a device is not of great importance. The IMPORTANT points are: these Controllers actually CONTROL steam flow. They RECORD. They INDICATE. They do these things automatically and with precision.
Whatever your steam control problems may be place them in the hands of our engineers for solution. Scientific steam flow control for oil refineries is our specialty.

THE CAMPBELL ENGINEERING CO.
282 South St., Newark, N. J.
Manufacturers of the TAR BABY BURNER to handle Fuel Oils, Water Gas Tar, Acid Sludge and Residue Fuels; information on Watermelon Type of Steam Control for Oil Stills; Pumpkinseed Type; ☐ the Tar Baby Oil Burner.
Without obligating us in any way, please send
☐ ☐
Name .....
Firm .....
Street .....
City & State .....

Items About Manufacturers

tive plants he became general manager of Armstrong Whitworth Company's locomotive department in England in 1919, in charge of the building and equipping of the locomotive works and of sales, engineering and manufacturing of locomotives. Shortly thereafter he was made general manager also of the pneumatic tool department, gas and oil engine department and also director of the works board of all Armstrong Whitworth Company's plants, which included shipbuilding and Diesel oil engines for marine work. In January, 1922, he joined the American Locomotive Company, which he had previously served, and became located at New York City. During the same year he was appointed assistant manager of the Schenectady plant, and in 1925 was made manager of that plant, where he served until his recent connection was made with McIntosh & Seymour Corporation.

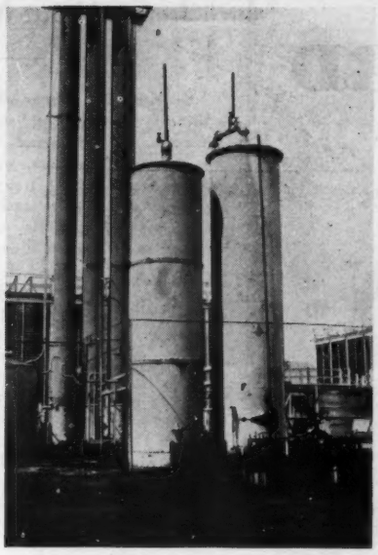
Oakite Products Company, Inc., 22 Thames Street, New York City, will present in Booth No. 90 at the Oil Equipment and Engineering Exposition, Los Angeles, March 16-23, economical salvaging and improved methods for cleaning serviced equipment and paint stripping practices. A miniature model producing plant and its related equipment in actual operation will be shown. The Oakite method for cleaning interiors of tanks, for cleaning small parts, waste and wiping rags and painted surfaces will be shown. P. A. Boeck, west coast division manager, will be in charge of the Oakite booth, with other representatives, including G. H. Boeck, R. E. Craig, C. S. Rankin, M. L. Witt, W. W. Hotchkiss, C. E. Johnson, F. Lee, H. W. Graham, M. E. Bagley and G. N. Benoit.

Arthur G. McKee & Company, engineers and contractors, with headquarters at Cleveland, has established an eastern office at 120 Broadway, New York City. The new office will be under the direction of Walter G. Mortland of New York. For many years Mr. Mortland has been active in the iron, steel and oil industries. The company has European headquarters office in London and is associated with Whessoe Foundry & Engineering Company, Ltd., Darlington, England, and Petroleum Engineering Corporation, Tulsa.

The Wm. Powell Company, Cincinnati, manufacturers of Powell valves and engineering specialties, announces the appointment of Howard Butt as manager of the engineering and export department, office at 50 Church Street, New York City.

Plibrico Company, 1800 Block on Kingsbury Street, Chicago, manufacturers of jointless firebrick, announces the appointment of L. R. Land, O. K. Transfer & Storage Company, 531 West Main Street, Oklahoma City, as Oklahoma representative. He will provide a statewide boiler-setting and furnace-repair service, and will maintain warehouse stocks of Plibrico furnace lining at the above location in Oklahoma City and at the Nichols Transfer & Storage Company, Tulsa.

Petroleum Exchange Corporation, 624 South Michigan Avenue, Chicago, announces the taking over recently of the exclusive gasoline sales of Misko Refineries, Inc., of Laredo, Texas, manufacturers of Mirando blending gasoline. This is a concentrate unusually high in benzol, which is being used for its anti-knock qualities.



What Oakite did for three Oklahoma absorption plants

Plant No. 1: Increased efficiency 30%.

Plant No. 2: Increased production from 21,000 to 23,000 gallons daily, and reduced waste gas from .1 to .03.

Plant No. 3: Made available a temperature of 350°, the highest since still was new; restored original production of 8,000 gallons daily.

These were the results, after the three absorption units had been cleaned by a method originated and developed by the Oakite Field Technical Division.

If your absorption units, or heat exchangers and oil coolers, are not functioning efficiently because of muck, salt deposits, and basic sediment, investigate this successful Oakite method and the economies that you are sure to gain by it.

Why not go over the details with our nearby Service Man, or drop us a line on your letterhead and further information will be forwarded to you. No obligation.

Oakite Service Men, cleaning specialists, are located in the principal industrial centers of the U. S. and Canada

Manufactured only by

OAKITE PRODUCTS, INC., 50B Thames St., NEW YORK

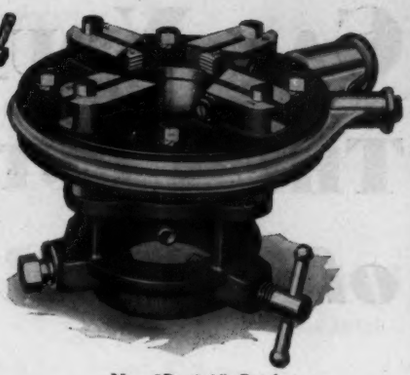
OAKITE

TRADE MARK REG. U.S. PAT. OFF.

Industrial Cleaning Materials and Methods

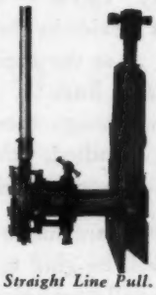
Patented Self-Contained Rear-End.

A Husky Man's Size Grip Screw.

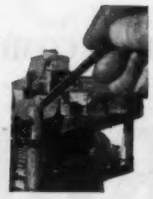


No. 8R, 1-2" Ratchet

Grooved Bolt and Washer.



Straight Line Pull.



Extra Heavy Upright Posts.

Simple, Sturdy Ratchet Pawl.

Open Die Slots for Easy Cleaning.

Safe, Enclosed Die Retaining Device.

Light in Weight.

A Reminder!

Remember These "Beaver" Advantages

When You Buy 1-2" Die Stocks

1. *Patented Self-Contained Rear-End.* Centers the pipe accurately—and without pliers or wrench. Simple, convenient, rapid, rugged, and accurate. Quickly and easily set to cut drip threads—also close nipples.
2. *A Husky Man's Size Grip Screw,* with sliding handle—easy to tighten by hand.
3. *Grooved Bolt and Washer.* Hardened steel washers that fall into the "size grooves" quickly and accurately locate the rugged guide bolts in position. No loose bushings to get lost.
4. *Straight Line Pull.* The Ratchet is on the die head—hence the pull is directly over dies—thus eliminating binding, or cocking which damages threads and wears dies and parts prematurely.
5. *Extra Heavy Upright Posts* mean greater strength, durability, rigidity, smoother operation, less trouble and repair expense. A standard mark near the top of each post enables you to cut standard, over or under as desired.
6. *Simple, Sturdy Ratchet Pawl* that stands lots of punishment yet is easily and quickly repaired on the job if ever necessary.
7. *Open Die Slots for Easy Cleaning.* You can't keep dirt, grease or chips out of die slots—back of the dies—thus ruining threads but a wiping cloth cleans these open dies slots in a jiffy.
8. *Safe, Enclosed Die Retaining Device.* Fully enclosed. No exposed spring to get knocked off. Dies don't fall out. You save the cost of many sets of lost dies.
9. *Light in Weight.* While the vital wearing parts are of heavy rugged construction, extreme simplicity of the tool results in lightness of weight—only 12¾ lbs. in the ratchet tool—(10 lbs. in the plain tool) as against 16 lbs. for other standard four post ratchet tools.
10. *Beaver Die Segments are Interchangeable.* Odd segments can be kept and used to "piece out" complete sets. A special "Beaver" feature and a big saving to you.
11. Dies interchangeable with other 4-post tools.
12. Low in price.

Try a No. 8 Plain or No. 8-R Ratchet—and see why so many leading shops are standardizing on the new "four-post" Beavers. Sold by leading supply houses.

Manufactured by

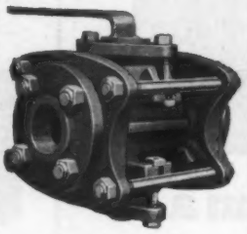
THE BORDEN CO.

518 Dana Avenue,

Warren, Ohio

CAN YOU AFFORD THE COST of CORROSION?

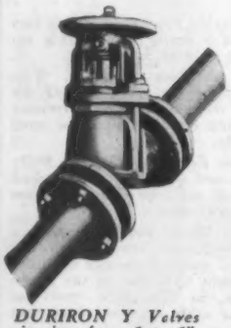
CORROSION of valves handling acids and acid sludges is a major item of expense. It involves not only the cost of the valve but the labor cost of replacement.



DURIRON "PR" Plug Valve

DURIRON Valves will handle all kinds of acids at all concentrations and temperatures. And Duriron Valves are "utility" valves — one valve can be used for any acid service in the refinery . . . on unloading lines . . . at the concentrator . . . on sludge acid transfer lines . . . at the treating plant. And even though there is grit in the material being handled, the hardness of Duriron protects it from scouring.

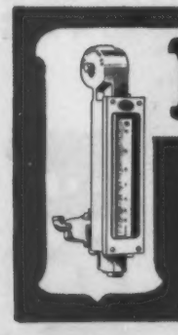
DURIRON Valves are made in several types and sizes. We will be glad to suggest the particular type that will best solve your particular problems.



DURIRON Y Valves in sizes from 1 to 6"

THE DURIRON COMPANY, Inc.
412 No. Findlay St. Dayton, Ohio

DURIRON
FOR ACID SERVICE



Flow Meters

THE MERIAM CO.

1954 West 112th St., Cleveland, Ohio

Items About Manufacturers

George D. Roper Corporation, Rockford, Illinois, has had published a 104-page book of interest to petroleum refiners and marketers. It thoroughly covers, with illustrations, a complete line of hand transfer pumps, truck tank pumps, and bulk station outfits, product of this company. This book contains valuable information on the different uses of the pumps outlines, instructions for installation, common reasons for pump troubles, an outlined method of determining the power required for pumping, formulas for determining size and speed of pulleys and gears, definitions of terms used in referring to pumps, and the pump construction necessary for different types of liquids. There are tables on useful equivalents, capacities of pipes, tanks and underground tanks, different types of conversion tables for determining foot head, pressure, suction and viscosity, weights and calorific values of oils and tables of friction losses and theoretical horsepower. The company is offering a copy of this book to anyone interested in pumping equipment, upon request to Rockford headquarters.

Rose-Hoskins Supply Company, Houston, announces the opening of a branch store at Beaumont, Texas, carrying stocks of Goodyear mechanical rubber goods, Youngstown pipe, Stockham fittings, Powell valves and Page leather goods. Location of the new branch, which is in charge of B. R. McLemore, is 1365 Crockett Street. This company was organized 14 months ago, opening a store at 910 Rice Street, Houston, of 15,000 feet of floor space, served by Houston Belt & Terminal Railroad. H. C. Hoskins, George H. Rose and R. P. Goodman, officials of the company, as well as B. R. McLemore, all were connected for many years with E. L. Wilson Hardware Company, Houston, prior to the absorbing of that organization by The Peden Company.

Refinery Supply Company of Tulsa has recently enlarged its service department, enabling its engineers to service all type of scientific laboratory and power plant equipment.

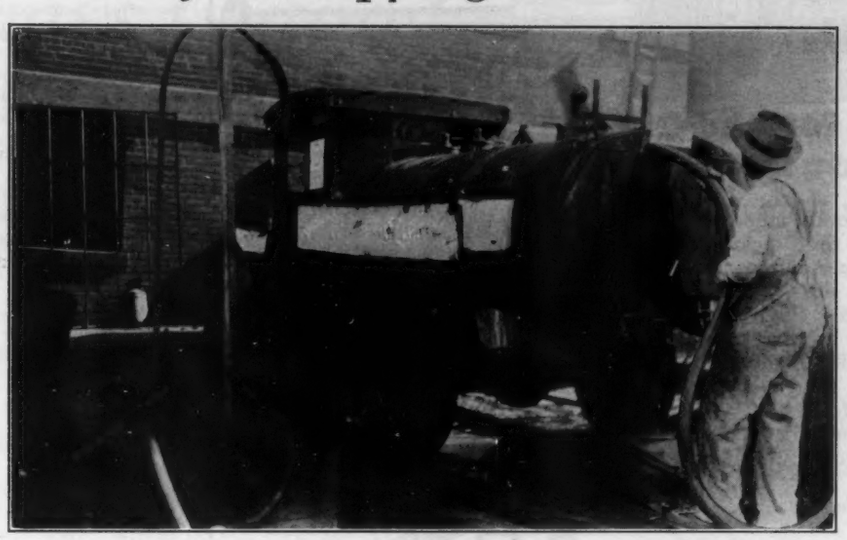
Schutte & Koerting Company, Philadelphia, announce the publication of a new bulletin covering their line of bleeder turbine protecting valves. It is for insertion in the SK valve catalog, to replace former bleeder valve literature mailed out by the company. This bulletin gives considerable data regarding construction features, sizes, prices and typical installations.

Stacey Engineering Company, which includes Connersville Blower Company, Inc., P. H. & F. M. Roots Company, Wilbraham-Green Blower Company and Stacey Brothers Gas Construction Company, has opened a branch office at 235 Montgomery Street, Rusk building, San Francisco. Sales and service of blowers, pumps, meters, tanks, holders, purifiers and other products of the organization are in charge of E. A. McCallum, who has been appointed district manager.

A. O. Smith Corporation, Milwaukee, Wisconsin, announces publication of a 54-page bulletin, entitled "The New Way of Designing and Building Gas Lines with Smithwelded Pipe." This bulletin supersedes "The New Way," published some time back by the company, and contains a great deal of valuable data and interesting information for men concerned with pipe and pipe lines. "Factors Effecting a Minimum Cost of Gas Pipe Lines" is a subject covering 15 pages of the bulletin, each page being illus-

CHARLITE HEAVY DUTY No. 1
for Stripping Paint

Trucks, Tanks, Drums, Tank Cars, Quickly Cleaned For Re-painting



Economical Efficient

Full Details on request

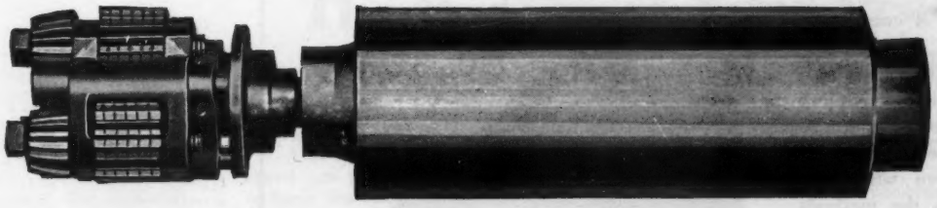
Charlite Division

CHARLOTTE CHEMICAL LABORATORIES

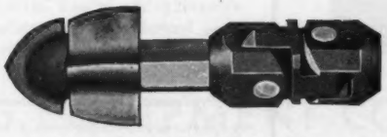
CHARLOTTE, N. C. 50 EAST 42nd ST., NEW YORK

Southwestern Distributors: GENERAL SUPPLY CO., Houston, Texas

ROTO TUBE CLEANERS



Roto air-driven Cleaner for Oil Still Tubes, made in sizes for 3″ tubes and larger.



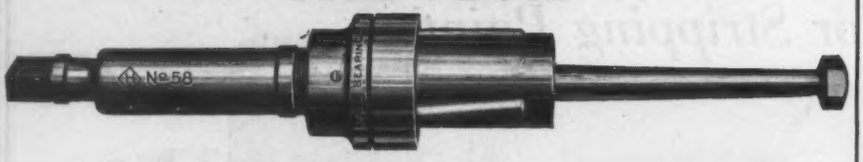
Roto Still Type Drill Head

Roto Unit Drill Head

THE ROTO CO.

Sussex Avenue and Newark St., NEWARK, N. J.

Heavy Duty Expanders for Still Tubes



Tools for the Oil Industries

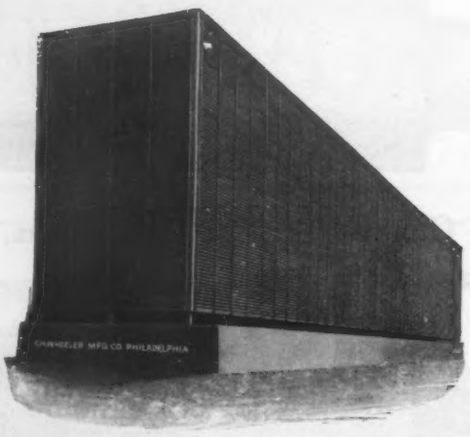
Hydraulic Pressure Pumps, 8000 pounds
Tube Expanders for Cracking Still Tubes
Hydraulic Pressure Pumps, 2000 pounds
Tube Expanders for Condenser Tubes
Hydraulic Pressure Pumps, 500 pounds
Tube Expanders for Steam Boilers
Screw Punches for Structural Shapes
Tube Expanders for Pipe Work
Screw Punches for Plate Work
Flaring Tools for Still Tubes
Beading Tools for Still Tubes
Hydraulic Jacks
Hydraulic Punches

A. L. HENDERER'S SONS
Wilmington, Del.
Established 1870
Expanders since 1884

Efficiently Re-cooled Water

As a result of correct design C. H. WHEELER COOLING TOWERS will give the maximum cooling effect under existing atmospheric conditions and temperatures. Even when humidity is high the methods used to break up the water into small particles will produce maximum cooling.

Every C. H. WHEELER COOLING TOWER is designed by competent engineers after a study of all the conditions that affect its operation.



C. H. WHEELER MFG. COMPANY
19th St., Lehigh and Sedgley Aves.
Philadelphia, Pa.

C. H. WHEELER of PHILADELPHIA

Items About Manufacturers

trated with an engineering chart to illustrate the subject matter. A 24-page section of the bulletin is devoted to pictorial outlines of laying lines, including methods and pipe connections. The remainder of the bulletin is devoted to covering engineering data on Smithwelded pipe. A copy of this bulletin is available by writing the company headquarters at Milwaukee.

Struthers-Wells-Titusville Corporation, Warren, Pennsylvania, has appointed James F. Sweeney sales engineer for the petroleum refining department of engineering. Mr. Sweenney was formerly with Smith Engineering Company, Kansas City, Missouri.

Worthington Pump & Machinery Corporation, Harrison, New Jersey, announces the publication of the following bulletins during the past month:

D-423-S4; power pumps, vertical triplex single-acting type, forged cylinders, pressure 1000 to 10,000 pounds; four pages. Supersedes D-423-E1.

D-450-B1A; deep well pumps, Axiflo, Hiflo, Coniflo; 32 pages. Supersedes D-450-B-1. This bulletin contains installation and sectional views, directions for determining the alignment and water level of a deep well, useful tables and descriptions of the pumps.

D-711-S5; power vacuum pumps, horizontal single double-acting; four pages. Supersedes D-92.

S-550-B2; gas engines, horizontal four-cycle double-acting, 36-inch stroke and over; 56 pages. Completely describes Worthington gas engines and gas compressors; useful pipeline tables, charts and formulas are added.

W-318-S2; centrifugal pumps, Type UA, two-stage volute; four pages.

W-318-S7; centrifugal pumps, Type UL, two-stage volute; four pages.

W-320-S1; centrifugal pumps, Underwriter fire pumps; four pages. Supersedes W-1074-B.

W-1200-B1; Worthington-Gilman rock drills and drill steel shop equipment; four pages.

Westinghouse Electric and Manufacturing Company, East Pittsburgh, is mailing out a folder, D.M.F. 5299, covering briefly the use of steam jet air ejectors in industries using vacuum processes.

Among the several types of air ejectors discussed in this folder are: two-stage condensing types with either surface type intermediate and after condensers or jet type intermediate condensers only; single-stage condensing or non-condensing ejectors; and compound ejectors on jet intermediate after condensers.

Westcott & Greis, Inc., Tulsa, has been named sales representative of Oceco equipment in the territory west of the Mississippi River excepting the states of Louisiana and Texas. This includes all the products of the Oil Conservation Engineering Company.

Professor Herman Diederichs, professor of experimental engineering and director of the Sibley School of Mechanical Engineering, Cornell University, and William D. Pomeroy, vice-president and general manager of Goulds Pumps, Inc., Seneca Falls, New York, recently were presented jointly the Melville medal of the American Society of Mechanical Engineers for an original paper of exceptional merit.

DON'T LOCK OUT IDEAS

Business is good for those who make it so

A recent survey of a dozen progressive plants revealed that in 1930 four were 28% ahead of 1929. Eight averaged 18% ahead. Business is good for those who make it so by seeking, seizing and applying new ideas for

improving efficiency in every department—improving products—improving processes—improving plants;

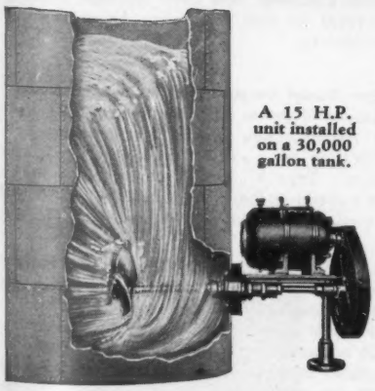
IN SHORT—by utilizing every modern aid to cut production and selling costs. Marked improvement can be made in every oil refinery by a careful, close-up study of all that is new and most modern in process development machinery, methods and equipment. A visit to the Chemical Industries Exposition, Grand Central Palace, New York, during the week of May 4th will be a profitable investment for you and your firm.

Management International Exposition Company

Thirteenth Exposition CHEMICAL INDUSTRIES

51731

LIGHTNIN



A 15 H.P. unit installed on a 30,000 gallon tank.

The Quality of Your Product Depends on Your Mixing Methods

THE quality of your products can be traced directly to your mixing operations! And although the patented features found exclusively on LIGHTNIN agitators speed up production, lower mixing costs, and introduce modern mixing methods without the necessity of new tank equipment . . . the definite improvement they make in the quality of any product is their chief claim to superiority.

Explosion-Proof Motors

Photo at right shows Portable Model "D" attached to an open tank. Explosion-proof motors furnished upon request.

All Sizes and Speeds—Direct Drive and Geared Types

Photo at right shows portable direct drive Model "M" attached to large tank. Our engineers will cooperate with you in determining the correct power, speed and size for your needs.

MIXING EQUIPMENT CO.
INCORPORATED
Originators and Largest Manufacturers of Portable Electric Mixers
New York Office and Sales Rooms
229 EAST 38TH ST., NEW YORK CITY
Factory—1040 Garson Ave., Rochester, New York

PORTABLE MIXERS

Hy-Speed

EXPLOSION-PROOF MIXERS

Hy-Speed Portable Electric Mixers are the most efficient machines manufactured for blending, compounding, mixing or agitating all oils and liquid chemicals.

They clamp to any tank or vat in one minute and produce a more thorough, rapid mix . . . . more economically than by any other process. Capacities from five to 50,000 gallons.

Write for your copy of «The Hy-Speed Age» ..... the Solution of your Mixing Problems.

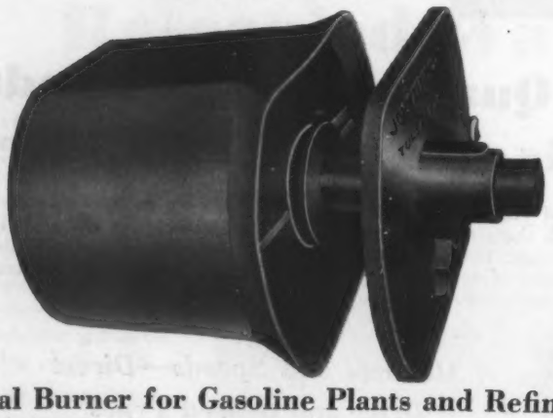
For mixing

LUBRICATING OILS
LIME AND OIL
FULLER'S EARTH & OIL
ALL LIQUID CHEMICALS

ALSOP ENGINEERING COMPANY
47 West 63rd St.
New York City

GAS BURNERS

Heat Without Flame



Special Burner for Gasoline Plants and Refineries

•

Special Bi-Mix Burners for Drilling Boilers
Low Pressure Burners for Heating Plants

•

Over Six Thousand John Zink Burners In Use

JOHN ZINK COMPANY

Oklahoma Natural Gas Building — Phone 4-9838
TULSA, OKLAHOMA

Items About Manufacturers

Dearborn Chemical Company, Chicago, announces the appointment of Arthur J. Carr as west coast representative with headquarters at 807 Mateo Street, Los Angeles.

D. J. Hill, Southern California representative of Shand & Jurs Company and Kinney Manufacturing Company, effective February 1, removed his offices from 630 West 6 Street to 1333 Santa Fe Avenue, Los Angeles, where it is possible to have the stock of equipment nearer the office.

A. H. Baer, sales manager of The Frick Company, Waynesboro, Pennsylvania, has been elected president of the American Society of Refrigerating Engineers. He has been associated with The Frick Company since 1898. For the past 25 years his work with this company has been that of estimating and designing refrigerating plants and apparatus. He became a member of the society of which he is now president in 1905. He has served on the council of the society for several years and was vice president of the organization during 1929-30.

Wm. G. Corey, sales representative to the oil industry of California for Pacific Gear & Tool Company has removed his offices from 630 West 6 Street to 1333 Santa Fe Avenue, Los Angeles.

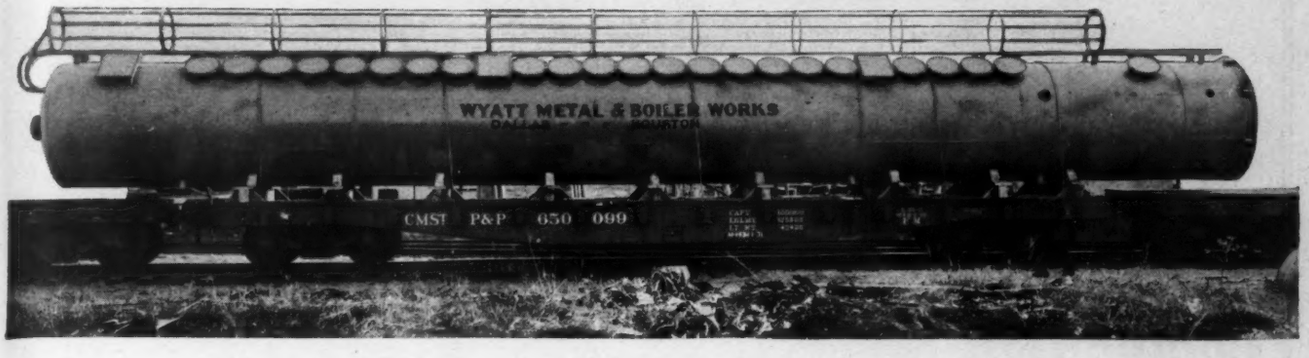
Croll-Reynolds Engineering Company, 17 John Street, New York City, manufacturers of refinery equipment, announces the following organizations with whom distribution arrangements have been made in the respective territories: Starkweather & Broadhurst, Inc. of Boston; E. H. Bollenbacher of Atlanta, Georgia; and Smiley Equipment Company of Kansas City, Missouri. The staff in the executive and engineering office has been enlarged by the appointment of D. H. Jackson as sales manager. He formerly served for six years the Elliott Company, and prior to that time was connected for four years with American Chemical Society.

Prat-Daniel Corporation, engineers and manufacturers of power plant equipment, 183 Madison Avenue, New York City, announces the publication of a new bulletin covering the Thermix Type V Multi-Cyclone dust collector. The bulletin is four-page, illustrated folder, and is available by writing the above address.

Lukenweld, Inc., a division of Lukens Steel Company, Coatesville, Pennsylvania, has published a 20-page, illustrated bulletin devoted to Lukenweld construction. Examples of Lukenweld construction are given in photographs reproduced in these pages, and the complete story of Lukenweld construction as concerns the manufacturer, is told. The advantages of rolled steel for modern machinery parts is taken up and discussed, Lukenweld development and research service is outlined, and the various phases of construction in the company's routine operation is described in description and pictures.

American Cast Iron Pipe Company, Birmingham, Alabama, has published a catalog devoted to the company's square flanged simplex condenser piping. Complete descriptions, with actual picture and wash drawing illustrations, are carried on this piping, and operating charts add value to the information given. The catalog is available upon request.

YOU CAN SAFELY DEPEND *on* WYATT PLANTS



for Heavy Refinery Work

On heavy plate work for refineries, natural gasoline plants or other uses in the oil industry, the two big plants of Wyatt at Dallas and Houston can serve you adequately.

Illustrated above is a sixty-eight foot bubble tower weighing 80,000 pounds. This tower is seven feet in diameter and is of welded construction throughout.

Underground storage tanks, truck tanks and other oil field storage and refinery equipment built to meet any specifications.

WYATT

Metal & Boiler Works

Capital $1,000,000

DALLAS **HOUSTON**

Type E Originated in 1927 by The Louis Allis Co.

The *First*
"Explosion-Proof" Fan-Cooled Motor

Type E Originated in 1930 by The Louis Allis Co.

The *First*
"Explosion-Proof" Air-Break Starter

Companion Pioneers!

Developed by Louis Allis engineers, these *companion pioneers* have brought safe individual motor drive to many hazardous industries. They have eliminated the need of fire walls, and the hazard and inconvenience associated with oil-immersed switches.

Tested and approved by Underwriters' Laboratories for Class I. Group D hazardous locations, these companion pioneers are inexpensive, simple, safe and easy to install wherever gasoline, naptha, alcohol, benzol, and equally hazardous liquids are made, used, or handled... widely used in bulk stations, terminals, refineries, natural gasoline plants, pipe line pumping stations, dry cleaning and chemical plants.

Write for complete information

WARNING: Do not confuse Louis Allis "Explosion-Proof" motors and starters with non-approved so-called "vapor-proof" apparatus. Real "Explosion-Proof" motors and starters must pass severe explosion tests to be approved by Underwriters' Laboratories for use in Class I. explosive atmospheres.

THE LOUIS ALLIS CO.
Milwaukee, Wisconsin
Offices in Principal Petroleum Centers

LOUIS ALLIS

"EXPLOSION-PROOF"
Electric MOTORS

THE MONTH IN REVIEW

In the following columns will be found a brief digest of happenings of interest to refiners, even with reference to a rumor or two!

RUNS to stills during January, according to the United States Bureau of Mines, amounted to 70,026,000 barrels, a daily average of 2,259,000 barrels. This compares with a total for December, 1930, of 71,581,000 barrels, or a daily average of 2,309,000 barrels. Of the total runs reported for January, 65,586,000 barrels or a daily average of 2,116,000 barrels was domestic crude and 4,440,000 barrels, a daily average of 143,000 barrels was foreign crude. Compared with January, 1930, runs for the first month of this year have shown a decline of 10,137,000 barrels, a daily decrease of 327,000 barrels.

DRILLING operations in the United States during February resulted in completion of 815 wells, of which 348 were producers having a combined initial production of 459,727 barrels of oil. This is the smallest number of wells completed in years and reflects the unsatisfactory state of the general oil market. Texas reported a material decline in wells completed during February, although initial oil production was larger than in January. The increase in initial production of Texas was practically all credited to the new East Texas area. Completion of 17 producing wells in Rusk County, East Texas, during February resulted in a yield of new oil amounting to 99,580 barrels daily. Oklahoma and New Mexico reported sharp declines in new production, as a result of a material decline in drilling in those states.

GASOLINE demand (domestic) in January showed a gain over the same month of last year of 1,053,000 barrels. Exports, however, showed a decline of 624,000 barrels compared with January, 1930. Domestic demand for January amounted to 26,844,000 barrels, while exports aggregated 4,903,000 barrels, a total demand of 31,747,000 barrels. While this represents a gain over last year, it also represents a decline under December, 1930, of 2,250,000 barrels in domestic consumption and a gain in exports of 517,000 barrels. Stocks of gasoline as of January 31 amounted to 42,818,000 barrels, compared with 49,676,000 barrels as of January 31, 1930. Gasoline production in January was 3,946,000 barrels lower than in January of last year.

BALANCE of exports over im- ports of all oils in January amounted to 4,056,000 barrels, compared with a favorable balance in January of last year of 4,489,000 barrels. Imports of crude and products during January amounted to 7,954,000 barrels, against 9,256,000 barrels last year. Exports of crude and products during January amounted to 12,010,000 barrels, compared with 13,845,000 barrels last year. This represents a decline in imports of all oils under last year of 1,302,000 barrels and a decline in exports of 1,835,000 barrels.

CRUDE price reductions were an- nounced recently in the Mid-Continent area, as well as in the Central West,

Carbondale Refrigeration for Refiners

CARMACO

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SALES OFFICES
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The packages illustrated above are your insurance that PIONEER OYSTER-SHELL LIME will be the same efficient chemical reagent when you use it as when it leaves our plant.

Solid steel drums for quicklime, and **three-ply bags** for hydrated lime, prevent deterioration in storage and loss in handling.

These Packages protect Pioneer purity

THE HADEN LIME COMPANY
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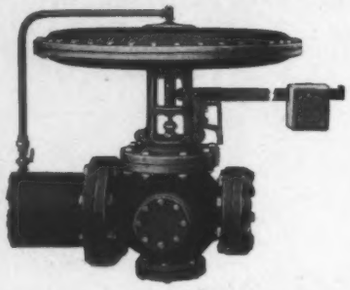
Automatic Cut-Off Regulators are on the job at all times. They automatically close the ports of the regulator valves. The valves must be opened by hand before the gas flow resumes.

There is no chance for dangerous explosions, because even though the diaphragm of the regulator should burst, this cut-off would stop the flow of gas immediately.

More than 40 years of experience in controlling gas pressure has taught us how to make this device dependable in its operation.



Organized 1884 — Oldest builders of regulators in the country. Built in all sizes from 1 to 24 inches; for all services 1 oz. up to 2,000 lbs. pressure per square inch.

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Indicator Body

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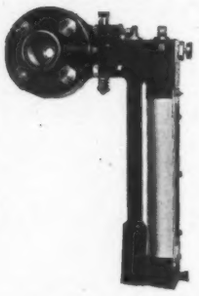
Your Pipe Line Flow at a Glance



Close-hook-up Type Flow Indicator

No intricate charts are needed to compute *your* pipe line flow when you install M-J-L indicators. These indicators are actually easier to read than are ordinary thermometers. They are calibrated to *your* required specifications.

Refineries are installing M-J-L indicators in increasing number due to their simplicity, and accuracy in operation. Made in any size from ½" up. Send complete specifications when ordering an M-J-L from your supply company.

Write for new series "E" Bulletins

MOREY & JONES, Ltd.

Manufacturing Engineers

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Los Angeles California

The Month in Review

Rocky Mountain and California fields. The reductions ranged from 25 to 40 cents a barrel in the Mid-Continent; from 25 to 60 cents a barrel in California and on an average of 35 cents a barrel in the Central West and Rocky Mountain fields. Illinois crude was reduced 50 cents a barrel. Mid-Continent oil of 36 gravity is now quoted at 59 cents a barrel, as compared with 95 cents formerly. The flood of cheap oil in the new East Texas area is attributed the chief reason for the slash in the general crude market.

ANOTHER group of lawsuits has been erased from the records of cracking patent litigation through an understanding reached between Universal Oil Products Company, owner of the Dubbs cracking process, and Gulf Refining Company.

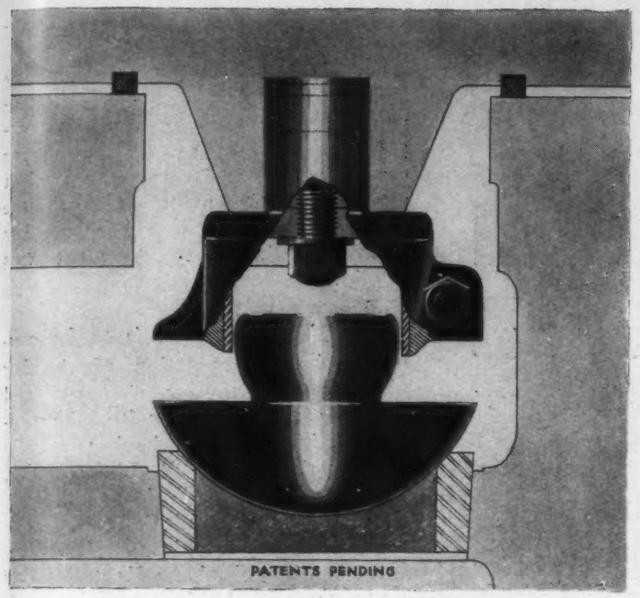
Universal Oil Products Company had sued the Gulf Refining Company on the charge that Dubbs patents were being infringed by latter through the use of the de Florez cracking process in Gulf Refining Company refinery at Bayonne, New Jersey. The agreement was signed in New York February 6 by President H. J. Halle of Universal Oil Products Company, and Vice-President C. B. Buerger, representing Gulf Refining Company.

The Gulf Refining Company paid a substantial sum in consideration of which Universal Oil Products Company has agreed to withdraw the infringement suit and to permit the Gulf Refining Company to go ahead in the development of its cracking operations within agreed limits without interference.

In return, the Gulf Refining Company also gives full immunity grants to Universal Oil Products Company and all of its present licensees under the Gulf Refining Company's pyrolitic cracking patents but not including Gulf Refining Company's aluminum chloride patents. Gulf Refining Company had sued several Dubbs licensees on infringement charges and these suits are now to be dropped.

On the day previous to this settlement, Atlantic Refining Company concluded a similar agreement with Universal Oil Products Company, Atlantic Refining Company paying for the rights from Universal Oil Products Company as relating to its own cracking developments. In return, Atlantic Refining Company gave an immunity grant under its Lewis and other pat-

CALMEC



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for Slush and Oil Pumps is the basis of comparison for

VALUE

in all oil fields alike because of its downright

EFFICIENCY

in operation, made possible by its correct, scientific, one-piece construction; its extreme

SIMPLICITY

which insures longer life, ease of installation—and genuine

ECONOMY

not possible with any other. All metal—no rubber to rot or wear. Universal. The valve for hot oil and all other pumping jobs. » » Write for complete information.

Announcement to All Refinery Engineers, Line Pipe Superintendents and Pump Manufacturers » » »

THE CALMEC MFG. CO., Ltd., is a new company, just formed, the outgrowth of and with the combined assets and man power of two reliable organizations behind it.

THE CALMEC VALVE is thoroughly original and has been developed in our shops. STUDY THE PRINCIPLE and also the results listed below and judge for yourself. No valve too small and none too large for us. Favor us with a trial order and then watch the valve do its part to prove worthy of our claims.

We List Below Some Experiences of Actual Users—Names on Request

1—Previous life of valves in 16″—24″—6″—18″ DOW..... 48 hours
CALMEC VALVES, same pump—same conditions 3000 hours and still going.

2—7—4½—10 Fairbanks, hot oil, valves with springs, lasted 24 hours. CALMEC VALVES now running 3 months and no replacement.

3—The small Gardner line pump putting up 100 pounds pressure. With the same steam consumption THE CALMEC valve increased the volume 30 per cent.

4—Pumping from tanks to main line, 8—5—12 Worthington cut down pumping time just 50% after CALMEC VALVES were installed.

CALMEC MANUFACTURING COMPANY, Ltd.

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WE KNOW THE PUMP BUSINESS » GIVE US A TRIAL

Sure it's a tough problem

. . . . . and nobody has licked it 100%

IF you burn sludge fuels in your boilers and have not already discovered the advantages of Hifire Brick for this special service condition, it will pay you to *lay up a trial setting of Hifire Brick* and check performance.

Many of the West's leading refineries have made this test. *Without exception they continued to use Hifire Brick as a result.* That is *real proof* of Hifire's ability to resist the havoc of sludge fuels better than brick formerly used.

Dont' be content until you are *sure* you have the best brick for your special purpose. Test Hifire under *your* conditions.

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DENVER DFC COLO.U.S.A.
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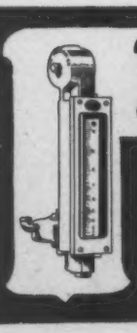


Flow Meters
THE MERIAM CO.
1954 West 112th St., Cleveland, Ohio

The Month in Review

ents to Universal Oil Products Company and its licensees.

Universal Oil Products Company had not sued Atlantic Refining Company, however, Atlantic Refining Company is building several de Florez cracking units. It was to assure against attack on infringement charges in the operation of these as well as its other cracking units that settlement was sought.

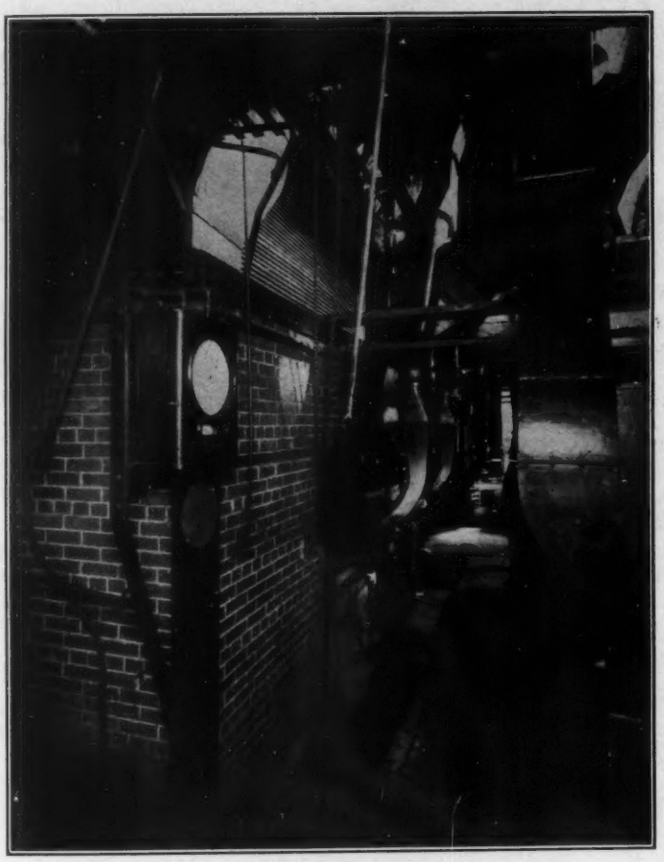
EAST Texas crude is to be consumed in the operation of refining plants at Angus, near Corsicana, and at Minerva, Texas, as result of the ownership of these plants having recently been transferred by R. L. Wheelock, receiver for Central Texas Refining Company, to Garland C. Kent, Corsicana, in settlement of a priority claim. Kent has organized the Kent Refining Company, with headquarters at Corsicana, to operate the two plants, and C. A. Middleton will be actively in charge of operations. Kent Refining Company will be supplied with crude from the Joiner field in tank cars through a working arrangement with Joe Butler, John Calhoun and associates, who have purchased 1,000,000 barrels of crude at a flat price of 40 cents per barrel at the well and are now at work in constructing a gathering system and a rack at Overton.

THE annual plant operators meeting of the Natural Gasoline Association of America will be held Tuesday, March 31, for the Ranger district. Dean Hiatt, Texas Pacific Coal & Oil Company is in charge of arrangements. The meetings will be held in the club building of Texas Pacific Coal & Oil Company at Thurber, Texas. The program for the morning and afternoon sessions will be announced shortly. A program for the evening session, including entertainment, is to be included at this meeting.

ALTITUDE Petroleum Corporation has announced the purchase of Peerless Oil & Refining Company's 5,000-barrel skimming plant and cracking units of the Jenkins type at Chanute, Kansas. E. E. Roper, formerly sales manager for Miller Petroleum Company, is sales manager. Altitude Petroleum Corporation plans to purchase "stripper" crude in Kansas, and oil from the Oklahoma City field. It is also reported that the company plans to consolidate interests it has in other refineries in Oklahoma and Texas to operate under one name.

Well Known Eastern Plant gets 400% "longer life," by laying-up BOILER ARCHES *with* KROMEPATCH

THE MULTI-BOND CHROME CEMENT



And in addition longer service life of refractory lining by laying all brick in KROMEPATCH Cement.

—Note the sectional view of the back Boiler Wall illustrated at the lower left . . . the KROMEPATCH joints "project" beyond the edges of the brick, which conclusively proves that they are more resistant to abrasion and destructive elements than the fire-brick themselves.

KROMEPATCH will not squeeze-out, bubble, crumble, or flux. In fact, KROMEPATCH ACTUALLY "PROTECTS" THE BRICK, and it has been proven that the joints are really "stronger" than the brick.

Use KROMEPATCH, and be assured of "longer life" from your Boiler Arches and Refractory Linings.

KROMEPATCH *is primarily high-grade Chrome Ore . . . It is shipped "Dry" in air-tight metal containers of 200 lbs. Net Weight . . . 212 lbs. Gross Weight.*

Sectional View of Boiler Back Wall
(Note how KROMEPATCH Joints "Project")

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E. J. LAVINO AND COMPANY
REFRACTORIES DIVISION
CHROME, MAGNESITE AND SILICA REFRACTORIES
BULLITT BUILDING PHILADELPHIA

"Pioneers in Chrome Refractories"

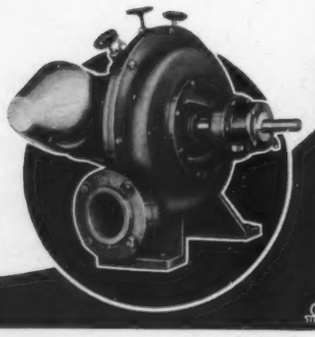
Give Them the Hard Jobs!

Put Coppus Turbines on the hardest jobs . . . . where service is most severe. Make them "prove their mettle"! They'll come across every time. On draft fans, recirculating fans, centrifugal pumps . . . . wherever steam drive can be used Coppus Turbines will adequately meet the demands for all heating and process work.

Turbine wheel is of the two row velocity stage impulse type . . . buckets are of non-corrosive and non-erosive metal and are cast into the wheel by a patented process. Valve and governor are of unique design and insure easy speed control . . . . Exhaust steam is free from oil and can be readily used for process work.

Coppus Engineering Corporation
360 Park Avenue
Worcester, Mass.

Our Bulletin 120-2 prepared especially for Oil and Gas Manufacturers tells about Coppus Turbines in detail. We will gladly send you a copy on request.



The Spiral Motion Is the Trick

That's why Hood's Chemico Spiral Packing Rings have been selected by so many engineers. The center hole prevents choking and clogging.

Made of acid-resisting shale—practically indestructible.

Used by all big producers because of the intensive movements.

Samples on request

B. MIFFLIN HOOD CO., DAISY, TENN.

The Month in Review

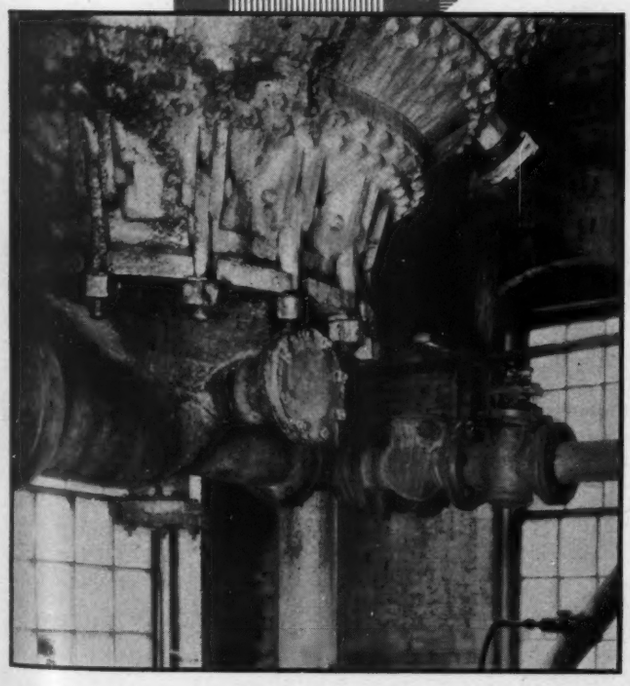
IN addition to the refineries reported under construction or proposed in the East Texas fields, which are listed elsewhere in this magazine (see Refinery and Gasoline Plant Activities Department and special story on East Texas Activities) later reports state that Constantin Refining Company is also planning to build a refinery at Tyler, Texas. This is a 5,000-barrel plant and will process crude from the Joiner field.

THERE are many rumors afloat to the effect that another major operator will build a refinery either in Denver or Brighton, to act as competitor for the Continental Oil Company's new $1,000,000 plant in Denver. Although there is no official recognition of these rumors and no statements made one way or the other, it is clear to those in the industry that such a plant would be a valuable asset to the company operating it since it would do away with excessive freight rates from Oklahoma or Wyoming refineries. The two companies most often mentioned in connection with the proposed plant are the Midwest Refining Company and the Cities Service Company.

THE refinery for Osage, Wyom- ing crude petroleum which Hugh Updike and associates announced some time ago for some city in the Black Hills is to be located in Rapid City. A 60-mile pipe line will be laid from the field to Rapid City, and about a million dollars will be spent in a modern refining plant. Financial backing is to be furnished by Seattle and Portland capitalists. It is reported that almost all of the operators in the Osage field will be stockholders in a new company to be formed for the pipe line and refinery project. Rapid City will provide a marketing center for the refined products of the new plant.

THE eighth Southwestern Gas Measurement Short Course will be held in the Engineering Building, University of Oklahoma, Norman, Oklahoma, April 21, 22, 23, with Professor W. H. Carson of the College of Engineering, director of the course, in charge of the sessions. The program committee is having its program printed for distribution to companies and individuals interests. The enrollment for this course has increased from 60 in 1924 to 450 in 1930 with last year's

THE HOMESTEAD QUARTER-TURN MAKES A CLEAN JOB OF HANDLING SULPHUROUS ACID



Sulphurous Acid! Engineers agree that it is a fluid difficult to handle, but Homestead Valves handle it in the same long-life, trouble-free, leakless way in which they handle other acids, alkalies, chemicals, distillates, gas, air, etc.

That is why Oil Refineries continue to adopt Homestead Quarter-Turn Valves as standard in their plants. It's because they are built to stand up under the conditions for which they are recommended.

Sealed bottom and bonnet, stem packed, carefully ground metal to metal seating surfaces, and positive cam seating action, are features which prevent leakage. And a variety of metals such as monel, steel, iron, brass, acid resisting bronze, etc. assure the user of maximum service under each specific set of working conditions.

Come to us with your next valve problem, and we'll gladly give you the benefit of our thirty-nine years experience in valve manufacture.

HOMESTEAD QUARTER-TURN VALVES

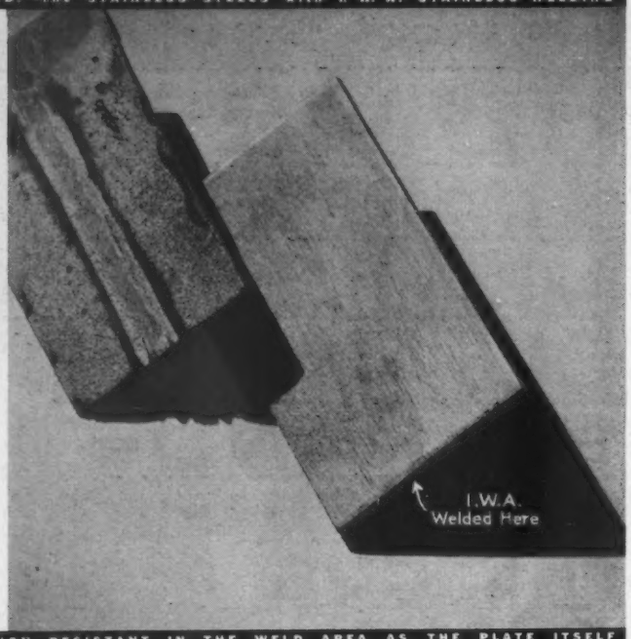
HOMESTEAD VALVE MFG. CO.

BOX 364 CORAOPOLIS PENNSYLVANIA

CORROSION CONQUERED! The STAINLESS STEELS with I. W. A. STAINLESS WELDING

We weld *any* of the high-chrome, high-nickel alloys — without preference or prejudice.

We specialize on just that — with methods and man power unconcerned with fabricating ordinary steel. We are tooled and equipped to handle work of any size required in the stainless alloys.



AS CORROSION RESISTANT IN THE WELD AREA AS THE PLATE ITSELF

See what boiling acid does to weld areas! Before immersion both specimens had equally sound and ductile welds—each made with a coated, alloy rod. The difference in corrosion resistance measures the advancement in our specialized metallurgical knowledge.

CAN you afford anything less certain than the I. W. A. technique of weld-fabricating the high-chrome, high-nickel alloys --- considering the fact that we are specialists with years and a dominant tonnage of successful work to which we can refer you? The value of the material demands fabrication where ability is beyond question.

Let us cooperate with your engineers in creating heat- and corrosion-resistant equipment of proper alloy and most economical design.

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KERLOW STEEL FLOORING COMPANY
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The Month in Review

registration including representatives from 22 states and two foreign countries.

ANOTHER refinery for the Houston refining district is indicated in the plans of Republic Oil Refining Company to erect a 5,000-barrel plant there. It is reported that the company will operate on high gravity crude produced by the deep wells in the Big Lake Field, West Texas. Operating offices of the company have been located in the Second National Bank Building, Houston, with D. W. Hovey manager of operations. E. D. Robinson, F. B. Parriott and other officials of Transcontinental Oil Company before its merger with Ohio Oil Company, are identified with this refining project. Crude supply will be obtained by tank car from the Big Lake Oil Company, which has a surplus of the high gravity crude after fulfilling existing contracts.

GASOLINE of high anti-knock value can not be distilled from the crude now being produced in the new fields of East Texas. From the relatively high pour tests of the crudes and the gas oil and residuum fractions therefrom, a comparatively high wax content is indicated. This indicates that the crude is mostly paraffinic in nature and is therefore not to be considered as an oil from which high anti-knock gasoline can be derived by skimming plant methods. One analysis of gasoline derived from the Gregg County crude reports unsaturate, hydrocarbons at 2 to 5 per cent, aromatics at 3 per cent, naphthenes at 25 per cent and paraffins at 67 per cent, indicating that the gasoline is predominantly paraffinic and therefore not of important anti-knock value.

A recent analysis of the Gregg County crude from Lathrop 1 of Arkansas Fuel Oil Company, Moncrief and Farrel, indicated a gasoline recovery by skimming methods of 39 per cent. Under atmospheric Hempel distillation the crude yielded 47.5 per cent gas oil of 33 gravity, and 10.5 per cent residuum of 10.0 gravity. This gas oil had a pour point of 80° F., which is indicative of relatively high wax content. The pour point of the residuum was reported at 60° F.

This crude has a gravity of 39.2° A. P. I., a viscosity of 42 seconds at 100° F., a pour point of 10° F., with sulphur reported as 0.37 per cent, and olive green color. Initial boiling point of the crude was 71° F. The percent-

. . . WHERE IS MAINTENANCE IN PIPING? . .

All maintenance and upkeep work in piping installations is at the joints. Progressive engineers, demanding the best in present day pipe fabrication, have adopted oxwelding. The ox-welded joint is strong, leakproof and permanently tight—100 per cent efficient . . . It eliminates joint maintenance.

See our exhibit at the 2nd ANNUAL OIL OIL EQUIPMENT AND ENGINEERING EXPOSITION, March 16 to 22, 1931, SPACE 151

THE LINDE AIR PRODUCTS COMPANY

Unit of Union Carbide and Carbon Corporation

126 Producing Plants UCC 627 Warehouse Stocks

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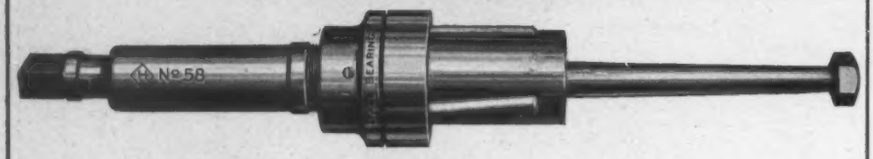
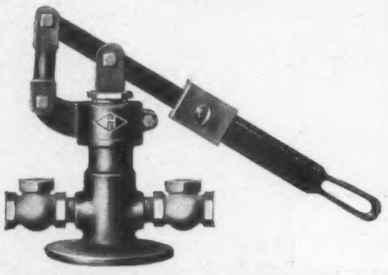
LINDE OXYGEN • PREST-O-LITE ACETYLENE • OXWELD APPARATUS AND SUPPLIES • UNION CARBIDE

Heavy Duty Expanders for Still Tubes



Tools for the Oil Industries

Hydraulic Pressure Pumps, 8000 pounds
Tube Expanders for Cracking Still Tubes
Hydraulic Pressure Pumps, 2000 pounds
Tube Expanders for Condenser Tubes
Hydraulic Pressure Pumps, 500 pounds
Tube Expanders for Steam Boilers
Screw Punches for Structural Shapes
Tube Expanders for Pipe Work
Screw Punches for Plate Work
Flaring Tools for Still Tubes
Beading Tools for Still Tubes
Hydraulic Jacks
Hydraulic Punches



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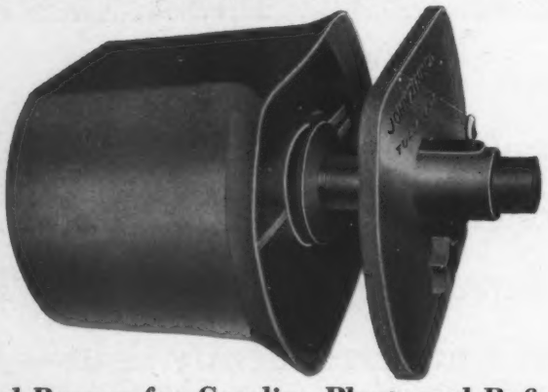
Wilmington, Del.
Established 1870
Expanders since 1884

GAS BURNERS

Heat Without Flame



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Special Bi-Mix Burners for Drilling Boilers

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Over Six Thousand John Zink Burners In Use

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TULSA, OKLAHOMA

The Month in Review

age recovery of kerosene, (which was not reported in the above analysis) gas oil, and fuel oil residuum, can, of course, be varied to suit plant operating conditions. Another analysis of this oil made to stimulate pipe still of 650° F., indicated the following recoveries: Gasoline, 38.5 per cent, with 57.5 gravity, good odor, nearly sweet doctor test, and 0.02 per cent sulphur. Gas oil of 35.8° A. P. I. gravity recovery was 22.8 per cent, and residuum was 36.9 per cent of 22.6° A. P. I. gravity and .474 per cent sulphur.

Crude from the Joiner or Henderson field, Rusk County, in a recent analysis was reported at 39.2° A. P. I. gravity, with a pour test of 25° F. and a sulphur content of 0.235 per cent. In this test 33 per cent gasoline was recovered, having a gravity of 58.5° A. P. I., I. B. P. of 122° F. and E. P. of 420° F. Color was reported as 30 plus, and sulphur as 0.008 per cent. Kerosene recovery was 15 per cent and the kerosene was reported at 40.2° A. P. I. gravity, 585° F. E. P. flash point 170° F. and 0.008 per cent sulphur. The gas oil recovery was 29.5 per cent of 30.5° A. P. I. gravity with a flash point of 285° F., a pour test of 75°, and a sulphur content of 0.23 per cent. Twenty per cent of residuum remained which weighed 15°. A. P. I., having a pour test of 100° F.

Crude from the Kilgore field is reported at 36.4° A. P. I. gravity, with a sulphur content of .24 per cent, a pour test of 20° F., a sweet odor and dark green color. This crude yielded 36.0 per cent gasoline of good color and relatively sweet, 10 per cent kerosene, 16 per cent gas oil of 60° F. pour test, 23 per cent wax distillate, and 12 per cent residuum.

NATURAL gasoline production of the world in 1929 increased from 41,470,069 barrels in 1927 to 58,200,357 barrels, a gain of 16,730,288 barrels in two years. During the same period, United States production increased from 39,074,857 barrels in 1927 to 53,183,048 barrels, a gain of 14,108,191 barrels. The United States is credited with 91.4 per cent of the world's output on natural gasoline in 1929.

Next to the United States, the Netherland East Indies furnished the largest foreign output of natural gasoline, followed by Peru, Persia, Rumania, Russia, Poland, Colombia and 10 other countries. Foreign production of natural gasoline has shown an increasing proportion of the world's total, having advanced from 5.8 per cent to 8.6 per cent of the total since 1927.

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THOSE Gargantuan twins—titanic pressure and terrific heat—are essential to the economical transformation of cheap black crude into high priced oils and gasoline.

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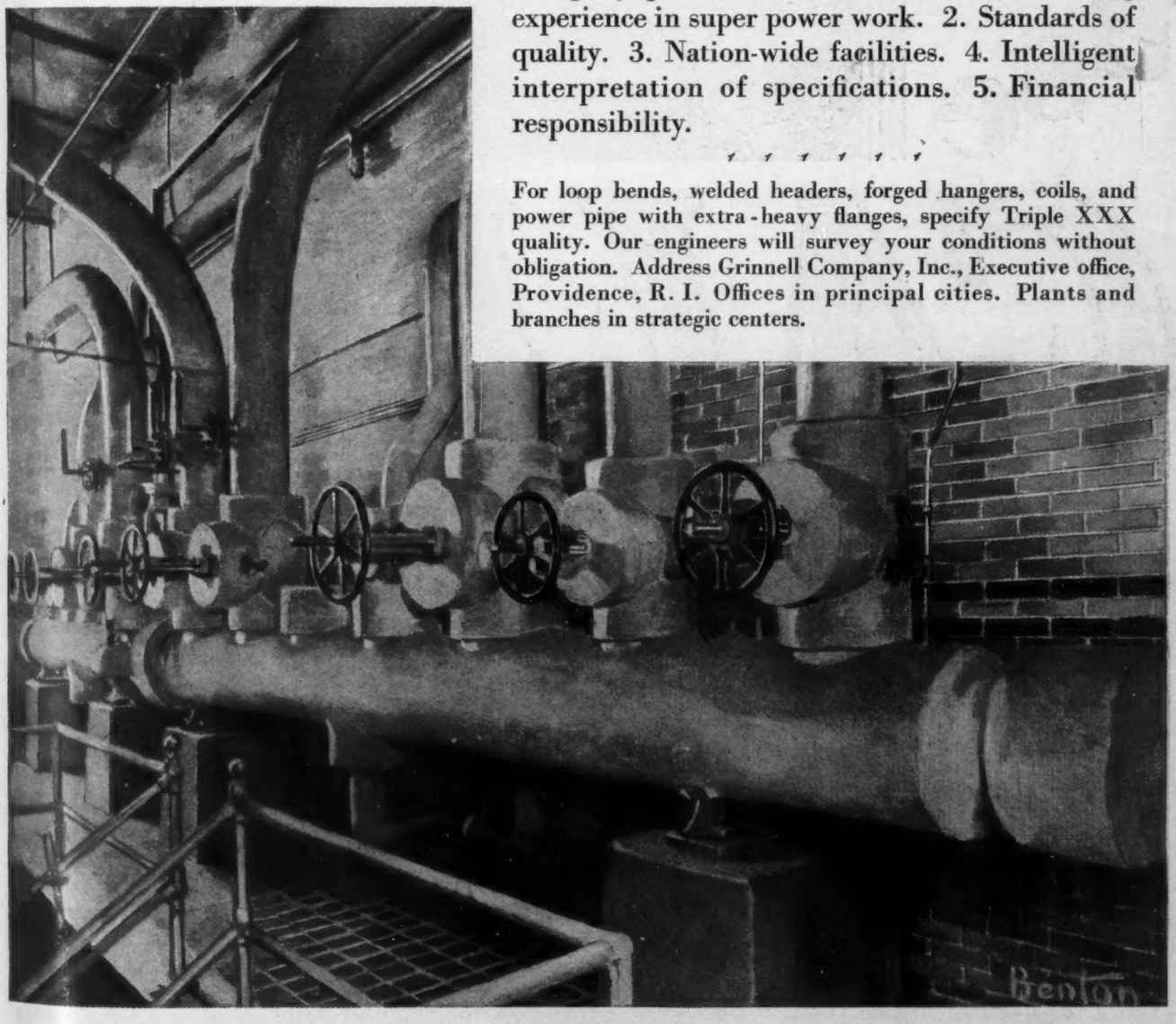

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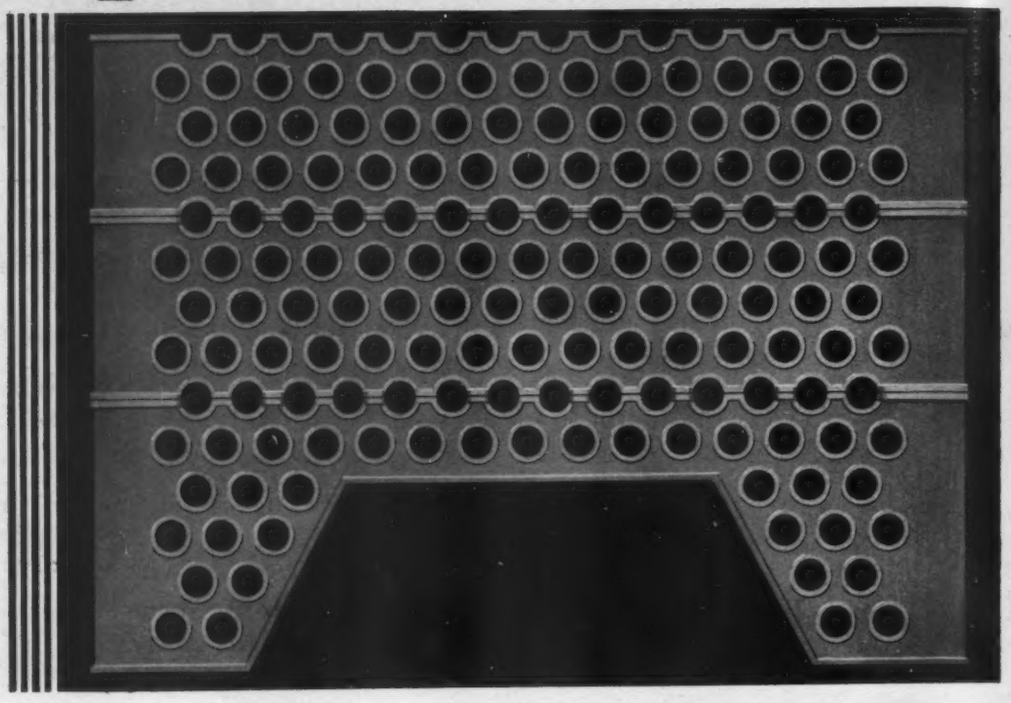

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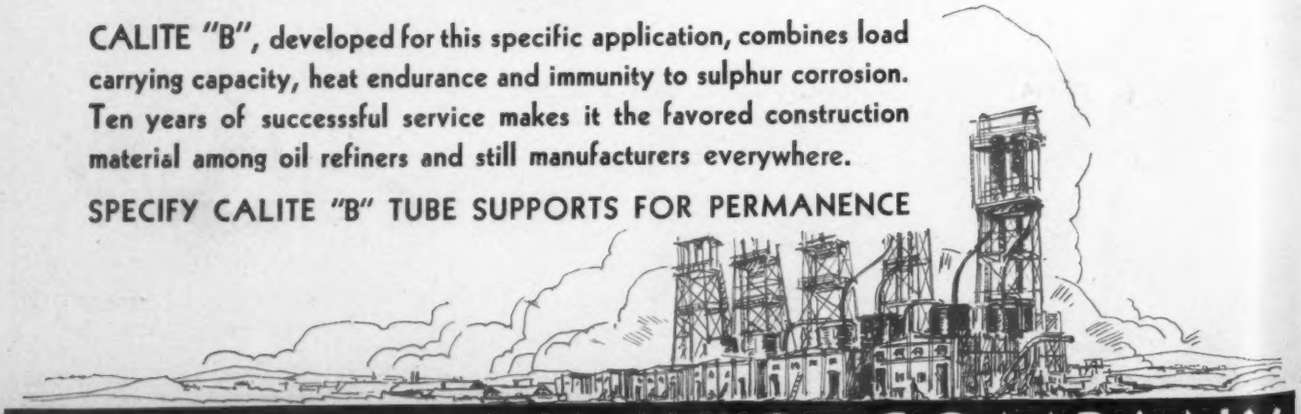

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